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The Development of a Sugar Cane Harvester for Hawaii Conditions *Richard A. Duncan*

Protective Coatings for Weathered Galvanized Sheets *M. L. Burgener and D. G. Carter*

Alcohol-Water Injection for High Compression Engines *J. C. Porter et al*

Machinery for Harvesting Napier Grass in Hawaii *John F. Cykler*

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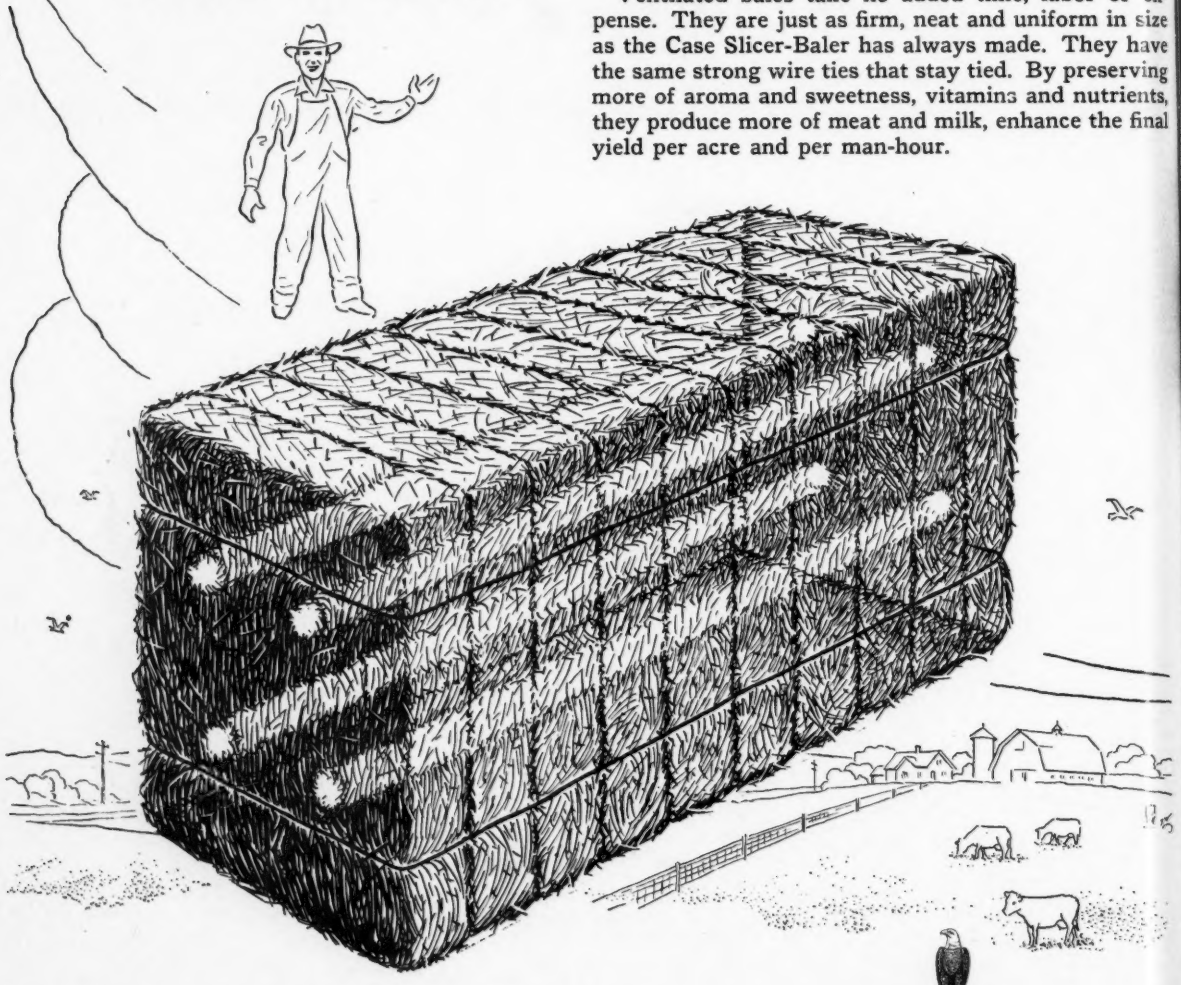

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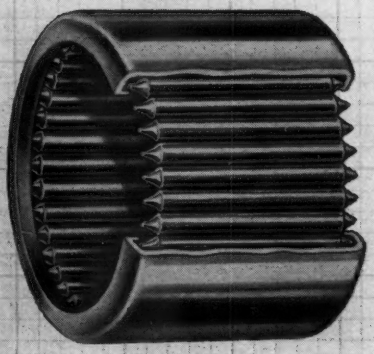

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CONTENTS FOR FEBRUARY, 1950

Vol. 31, No. 2

EDITORIALS 63

DEVELOPMENT OF A SUGAR CANE HARVESTER 65
By Richard A. Duncan

PROTECTIVE COATINGS FOR WEATHERED GALVANIZED SHEETS 67
By M. L. Burgener and Deane G. Carter

ALCOHOL-WATER INJECTION FOR HIGH COMPRESSION TRACTOR AND AUTOMOBILE ENGINES 71
By J. C. Porter, M. M. Gilbert, H. A. Lykins, and Richard Wiebe

HARVESTING NAPIER GRASS IN HAWAII 76
By John F. Cykler

FLATLAND SOIL CONSERVATION 78
By B. A. Myers

NEWS SECTION 80

PERSONNEL SERVICE BULLETIN 94

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Aetna Ball & Roller Bearing Co. 51
American Zinc Institute 84
Armco Steel Corp. 56
Blood Brothers Machine Co. 57
J. I. Case Co. ..... 2nd Cover
Caterpillar Tractor Co. 62
Chain Belt Co. 58-59
Delavan Mfg. Co. 88
Electric Wheel Co. 95
Ethyl Corp. 83
Firestone Tire & Rubber Co. 52
French & Hecht, Inc. 94
General Electric Co. 85
Ingersoll Steel Div., Borg-Warner Corp. 64
International Nickel Co. 87
James Mfg. Co. 93
Johns-Manville Corp. 89
Libbey-Owens-Ford Glass Co. 55
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EDITORIAL

New Knowledge and Better Living

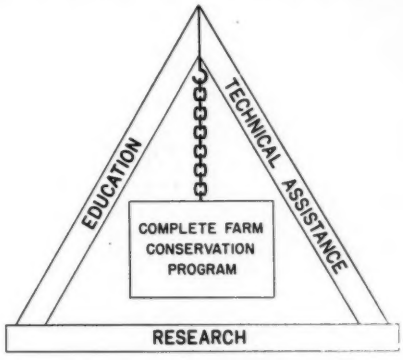
A MAJOR question of national public policy has reached the "show me" stage. A serious mistake may be made unless citizens and their representatives in Congress are shown the significance of research in soil and water conservation, in terms of everyday living.

The question is, shall our well-being be pegged at a fixed level — the level which can be provided by *present knowledge* of means by which our agricultural resources can be conserved and put to their fullest use? Or is soil and water conservation a field of human activity in which, as in many others, scientific research can produce useful new know-how worth far more than its cost?

Soil conservation has become quite well established as desirable in principle. Less clearly understood is the manner in which it may best be accomplished.

In the accompanying figure a member of the American Society of Agricultural Engineers has used the theory of models to aptly express by analogy some fundamental relationships in organization for progress in a technical field, with particular reference to the conservation of agricultural resources.

Together, the three sides of the triangle are shown providing a stable support for a complete farm conservation program.



Research, Education (or Extension), and Technical Assistance are all essential to the development of fully effective conservation and efficient use of all land

It is apparent that no one side of the triangle can be weakened or shortened without reducing the stability of the triangle and its capacity to support a sound conservation program.

The place of research as the base or foundation element of the triangle emphasizes its importance as the one means by which increasing knowledge can be most effectively developed and made available for application by man. It is the source of much of the new, more detailed, and more exact information most needed and most difficult for those in education or extension and technical assistance to obtain.

There is a danger at present that the research base of the triangle already has been reduced to a dimension which will decrease the effectiveness of the education or extension and the technical assistance sides, and that support for research will be further reduced. The number of technical workers in the research branch of the Soil Conservation Service has now been reduced to 154, and these attempt to cover the diverse problems of the entire United States for the thousands of men in the technical assistance and educational or extension phases of the Soil Conservation Service program, as well as the new problems brought up by the soil conservation districts and individual farmers. Our investment in research on the subject has been reported as less than 3 per cent of our annual national investment in soil and water conservation. It may be cut even lower if the public cannot be shown the value of new know-how applied to the soil source of its daily bread.

In general, the men engaged in the educational and technical assistance sides of the program appreciate the value of the research side, and the importance of its being continued. They know it as the source of much of the working knowledge they already have. And they are under pressure from farmers to show simpler and lower-cost ways of practicing conservation more completely and effectively, with stronger incentives in the form of earlier and larger cash returns. More and better know-how can greatly increase the effectiveness of their work and their service to the public.

One of the most promising possibilities of getting conservation practiced more extensively by a larger percentage of farmers is commonly overlooked. It is the probability that additional research can make conservation measures considerably more attractive to farmers than they are at present, by lowering their initial cost, simplifying procedure, and improving results.

Without fear of contradiction we submit the case for conservation research in the following points:

1 Soil and water conservation is a logical and promising field for further profitable research. It deals with physical materials, forces, and reactions subject to natural law and having a direct bearing on how long you and others may eat three square meals a day. There is much yet to be learned about these matters.

2 Research is most efficiently done by research specialists working in a well-organized program. This has been well proven by industrial organizations noted for their efficiency, and by various governmental departments in which research has been adequately supported.

3 The Soil Conservation Service of the U. S. Department of Agriculture has the background, trained personnel, and a sound, well-developed, direct-approach program ready to tackle many of the problems encountered by its men engaged in education and extension and in providing technical assistance. In the interest of effectiveness of its whole program its research activities in cooperation with the state agricultural experiment stations, warrant increased support.

4 No other federal, state, or private agency or combination of such agencies is comparable in potential ability or readiness to lead a national program of research, to introduce its results into practice more quickly, or to distribute the rewards of its work more equitably.

5 Soil Conservation Service research is of benefit to the entire population, in terms of greater security of future food supply; possible reductions in cost of food to the consumer; improved quality of food; as a factor in maintaining and improving farm and general prosperity; and as a means by which the occasion for and cost of direct financial aid to agriculture may be considerably reduced.

Desirable investment in conserving and increasing our national means is in danger of being confused with the undesirable profligacy of living beyond our means. Our soil is the main foundation of our national wealth and appropriations for any and all purposes.

Our increasing population is rapidly reducing its productive acres per person toward a figure which, based on present knowledge, can only mean a lower standard of living. At the same time, and in spite of concentrated effort to get present knowledge applied to the fullest extent, our soil is still eroding at the rate of about 5,000 100-acre farms per year. Is this a time to peg our future hopes to a vain idea that our present knowledge is adequate? Or to trust to luck for the production of the new knowledge needed to better protect our irreplaceable soil source of our three square meals a day?

Is this a time to say that an effective soil and water conservation program can be carried forward without the support of a firm, broad foundation of research? Let anyone who says so emphasize his point by arguing it to his heart's content while standing firmly and comfortably on one leg.

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AGRICULTURAL ENGINEERING

VOL. 31 FEBRUARY, 1950 No. 2

Development of a Sugar Cane Harvester

By Richard A. Duncan

MEMBER A.S.A.E.

IN RECENT years the sugar industry in Hawaii has been impelled more and more toward mechanization of all field operations. Increased operating costs, without a corresponding increase in gross returns, and the increasing scarcity of field labor willing to do the more arduous tasks have both contributed to this trend. Some phases such as land preparation, planting and ratooning have mechanized very well. The use of standard types of field machines has resulted in an improvement over the methods utilizing hand and mule power. Such has not been the case in the mechanization of harvesting.

The sugar cane stalk is thick and tough, with a normal size from 1 to 2 in in diameter. The normal cropping cycle is 18 to 24 months, with most of the cane stalks recumbent. The average stalk length is approximately 15 ft, with a maximum stalk length of about 28 ft. The yields normally range from 65 to 130 net tons per acre. At harvest time the first operation is to set fire to the cane to get rid of the dry leaves and some of the green leaves. Sometimes there is no burn, or the burn is partial because of rain, so it is necessary to be able to operate in unburned as well as in burned cane.

The problem is to cut the stalks loose from the stool portion at the soil surface and then pick up this mass of heavy, recumbent stalks from a soil surface which varies from dry and mellow to wet and soft. A wide range of terrain and surface conditions add to the difficulties.

The different types of harvesting machines developed and in use for other grasses have been of little direct help on this problem. At the present time the common types of harvesting machines are the rake and the grab. The rake is used as a push rake mounted on the front of a track-type tractor or as a drag rake which is cable-operated by pulling back and forth between two tractors equipped with winches. The cane is placed in windrows which extend across, not with, the rows. Most of the cane loading is done by track-laying cranes equipped with grabs which are also used sometimes to harvest heavy-tonnage cane by grabbing the standing, uncut cane off the surface of the field. The increase of trash, soil, cane stools, and rocks delivered with the cane to the mill required the development of cleaning (wet wash and detrashing) plants at the mills to condition the cane for milling.

A factor which adds to the cost of this over-all system is the sugar lost. Sugar is lost by the mutilation of many stalks in the field operations and the damage caused by the washing and detrashing in the cleaning plants. Since the cleaning plants are not perfect in performance, varying proportions of trash, tops, stools, and soil accompany the cane up the carrier to add to the factory difficulties. Added to these problems is that of ratooning for the next crop because of stools removed and soil compaction. This may appear to be a dismal picture of mechanical harvesting; however, it should be emphasized that harvesting as now practiced has enabled the industry to continue to produce and retain its place in the world market as a producer of cane sugar.

Efforts have been made from time to time during the past 30 years to solve this problem of a harvester for recumbent cane. Some of this work was done on a development basis, but in many cases it consisted of conceiving and then building. All this work has added to the accumulation of general information pertaining to the problem and has been of definite value. It was interesting to note that none of these machines had adequate ground cutting. Some cut satisfactorily with limitations as to conditions; others failed completely on the ground cutting. An analysis of the problem indicated very definitely that first the ground cutting phase must be accomplished satisfactorily over a wide range of conditions.

This paper deals with the harvester development which was initiated for the unirrigated flat culture cane. Of the 206,500 acres in sugar cane, about 88,800 acres are unirrigated flat culture. In setting up this project it was decided to approach the problem on the basis of experimental machines limited to one row, one way, and one operation. This also gave the best possibility of keeping each machine within reasonable

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1949, as a contribution of the Power and Machinery Division.

The author: RICHARD A. DUNCAN is associate agricultural engineer, experiment station, Hawaiian Sugar Planters' Assn., Honolulu, T. H.

AUTHOR'S NOTE: The author wishes to acknowledge the cooperation of individuals and organizations who assisted with this project.

Fig. 1 (*Left*) Front view of sugar cane harvester, developed for Hawaii conditions, showing cutting knives and pickup • Fig. 2 (*Right*) Right-hand side view of the machine

limits of simplicity and maneuverability. In the future was the objective of a machine which would do quality work by cutting the cane off at or near the ground surface without disturbing the stool portion, and then handling it without mutilating it and/or combining it with extraneous material.

In considering the ground cutting it was interesting that previous work had shown that a cutting device such as a sickle bar (which required that the cut stubble bend as the thickness of the bar below the cut passed over) would not work with cane, because a short stubble as thick as 2 in in diameter does not bend. As we progressed it became definite that there could be no obstruction below the cutting edge. Some test work gave us an indication that a free-cutting knife moving at around 3000 fpm would cut cane under field conditions. This work also brought out the desirability of keeping the cutting knives as thin as ⅛ in, if possible, and the cutting edge sloped back with a rake angle of about 25 deg.

The fact that most of the cane stalks are in various stages of recumbency and not all standing erect has been considered one of the big problems in developing a cutter or harvester. A premise was set up to take advantage if possible of this recumbency by picking up and handling this tangled mass as a continuous blanket or ribbon as it was being cut loose at the ground surface and from the adjacent cane. Heavy and possibly even heavier future yields had to be considered.

After some development and field operation we had a one-row cutter which was a cutter bar attached to a frame mounted on a track-type tractor. A rotary free-cutting ground knife was carried on a stub shaft which turned on bearings mounted in the hollow bar section and was turned by a chain drive in the bar. A pickup roll was mounted on the leading side of the cutter bar to lift the blanket of cut cane and start it over the bar. Some development was required before the pickup roll could be operated in trashy conditions. As part of the pickup roll there were two pickup tines which extend forward and straddle the row being cut. There were several lug-linked chains traveling over the bar to keep the blanket of cane moving. On the outer end of the bar there was a vertical double-scissors-type knife which cut the blanket or ribbon of cane loose from the adjacent cane. The power required to operate the cutter-bar assembly was supplied by an auxiliary engine mounted on the frame. This was found necessary in order to maintain the optimum speed of all moving parts. The necessary control and flotation for the cutter bar were developed to where the cutting height of the ground knife seldom varied more than one inch from the ground surface and the leading or cutting edge of the knife was always lower than the rear edge. The rate of tractor speed while cutting varied up to 2¼ mph, depending on conditions. A push rake was used at first to accumulate the cut row of cane and shunt it out of the way.

After accomplishing a satisfactory job of cutting, we turned our attention to picking up this cut row of cane as a continuous operation and disposing of it in a satisfactory manner. The pickup-windrowing unit developed had a pickup-elevating conveyor attached to the right side of a track-type tractor which dropped the cane onto a cross-conveyor mounted across the back of the tractor.

The cross-conveyor was driven through a disk clutch, and as the cane accumulated back of the discharge end of the elevating conveyor, it was moved over by engaging the clutch momentarily until the 20-ft conveyor was piled full. The clutch was then engaged and the conveyor unloaded into a pile. By unloading the conveyor at regular intervals heavy windrows were formed which extend across the rows. Up to 2500 lb of cane could be accumulated on the cross-conveyor and the distance between windrows averaged about 150 ft. The conveyors were run by an auxiliary engine so as to keep the machinery operating at the optimum speed regardless of ground speed. Speeds up to about 2¼ mph were possible.

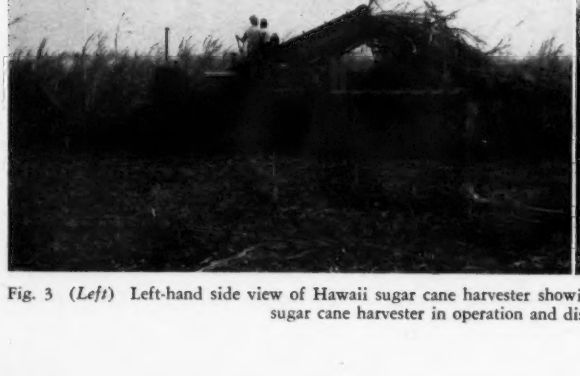
Under some field conditions it was essential to be able to carry part of the weight of the pickup end of the elevating conveyor on the tractor. It was also essential that the gage wheels be rolling on the ground to gage the height of the pickup roll, even though they were not carrying all the weight. This was worked out by mounting the hydraulic-lift cylinder so that it acted against a set of compression springs. By leaving these springs partially loaded we attained the effect of flotation. Under normal conditions the operator made no adjustment of the operating height of the pickup, or the load being carried on the tractor. The outboard weight of the side-elevating conveyor was carried on a 13:00 x 24 pneumatic tired wheel. By locating this wheel approximately in line with the balance point of the tractor, the tire rolled on the arc of a circle when the tractor turned in either direction.

The combined work of the cutter and the pickup-windrowing unit was better than the over-all results of hand work under similar conditions. This was the first time machines had set the pace for quality work.

One point that was kept constantly before us by the industry was the necessity of producing a machine that would first eliminate the rake. The desirability and possibility of combining the principles of the two machines into one became apparent. This would give a unit that would fit in with the standard operation of grab loading windrowed cane into trucks or rail cars. It also offered a good possibility in the wetter area where transporting cane by flume was still the most satisfactory infield transport, since the windrows extend across the rows and down the general slope.

The combined unit is similar in arrangement to the pickup-windrowing machine, with the cutter knives added to the pickup-elevating conveyor. Starting with the first field operation, the results of this step three machine have been good. The principles developed in the two separate operation machines carried over into the combined machine. The several unknowns which developed in the combining of the two sets of principles did not prove to be serious problems.

The prime mover is a standard 80 hp track-type tractor. The main frame and attached assemblies are designed so that the unit can be transferred to another similar tractor. A 50-hp diesel auxiliary engine is used to operate the elevating conveyor including knives and pickup *(Continued on page 70)*



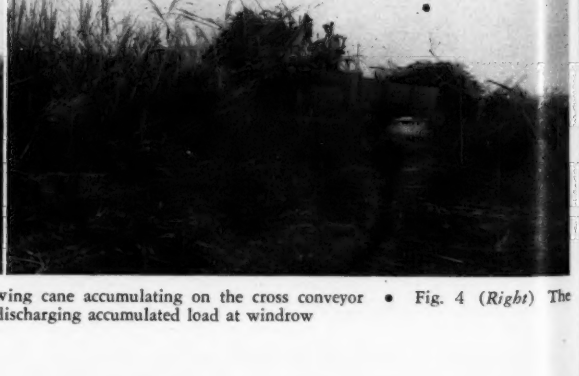


Fig. 3 (*Left*) Left-hand side view of Hawaii sugar cane harvester showing cane accumulating on the cross conveyor • Fig. 4 (*Right*) The sugar cane harvester in operation and discharging accumulated load at windrow

Protective Coatings for Weathered Galvanized Sheets

By M. L. Burgener and Deane G. Carter
JUNIOR MEMBER A.S.A.E. FELLOW A.S.A.E.

THE extensive use of galvanized metal sheets for siding and roofing on farm buildings presents a common maintenance problem. Prolonged weathering deteriorates the zinc coating and exposes the underlying metal sheet to rust action.

It is possible to prevent rusting by coating the sheets with protective paint. Good single-coat applications may give adequate protection for 6 to 7 years; two-coat jobs may last twice as long. Many considerations are involved, however, such as determining the kind of paint to use, deciding on the proper time to repaint, finding the best method of application, and evaluating results of the tests.

As early as 1906 the American Society for Testing Materials established paint tests at Havre de Grace, Md. Many other experiments have since been made or are still in progress. Paint tests alone may be meaningless, however. Numerous variables affect performance so that many replications are required and a knowledge of test procedure and control is necessary to evaluate results.

This paper reports the results of a particular series of tests which, together with related information from various sources, were presented as a graduate thesis at the University of Illinois. Emphasis is given to (a) a discussion of the tests and test procedure, (b) methods of analyzing data, (c) criteria for determining the life of protective coatings, and (d) evaluation of the tests.

Description of Tests. The tests reported here were established and carried on by the American Zinc Institute. The first specimens were coated in 1932, and by 1938 a total of 91 paints had been used in the project. All coatings then regarded as suitable for use on metal were included. Some were one-coat applications, while others were used in two-coat combinations (Fig. 2). The more common paints were used on several panels; a few were applied to only one or two sheets. Application was made with hand brush. Most sheets were wire-brushed before painting; others had no preliminary treatment.

Most of the test panels consisted of one-sheet strips about 24 in wide, extending the entire length of the roof slope. An exception was made on large buildings, in which case the roof was subdivided horizontally into two sections. In any event, the smallest panels provided about 16 sq.ft of surface.

All four directional exposures were included in the test. Paints were applied at random locations, although each paint was not necessarily tested on all four exposures. No preference as to location was given intentionally to any treatment. The angle of the roofs ranged from 22½ to 45 deg with the horizontal. In all, the test panels covered the roof area on seven farm buildings on the Harwood Farm, near Donnellson, in southwestern Illinois. The rural location corresponded to the least severe ordinary exposure condition, according to the classification of atmospheric types used by the American Society for Testing Materials(1)*. The distances from the dwelling were sufficient to prevent pollution by smoke from the house heating system.

Preliminary results based on this series of tests were reported by Bartells(2) and reference was made to them by Matthews(3). In 1948 the complete record of the 16-yr test program was submitted to the department of agricultural engineering of the University of Illinois for an engineering analysis. A member of the experiment station staff examined the experiment in detail and took part in the final inspection. The analysis and report were made under a trust fund provided for the purpose by the American Zinc Institute.

Limitations. It should be understood that this was a practical experiment under field conditions. No claim is made for the more exacting analysis and control which is characteristic of laboratory determinations. Authorities (4, 5) agree, however, that regardless of laboratory precision, accelerated tests do not predict the service life of a paint. The final trial must be under field conditions.

In these tests, the galvanized metal sheets were not uniform in surface condition. According to the originator(2), the sheets ". . . . offered a variety of surfaces for the application of paint. Practically all sheet surface conditions, from good zinc coating to bare, rusty base metal, with all intermediate stages of rusting, were included. In some cases all of these conditions might be present on the same sheet, ..."

The lack of uniformity noted made it more difficult to interpret results. This condition, however, is characteristic of weathering as it occurs on farm building roofs. The variation in surface condition within individual sheets and among the sheets on one building is shown in Fig. 1.

*Numbers in parentheses refer to the appended bibliography.

This paper was prepared expressly for AGRICULTURAL ENGINEERING, and was taken from a thesis, entitled "Protective Coatings for Galvanized Roof Sheets," submitted to the graduate college, University of Illinois, by Mr. Burgener in partial fulfillment of the requirements for the degree of master of science in agricultural engineering, August, 1949.

M. L. BURGENER, formerly graduate assistant in agricultural engineering, University of Illinois, is presently agricultural engineer, Portland Cement Assn., Chicago, and DEANE G. CARTER, is professor of farm structures, University of Illinois, Urbana.

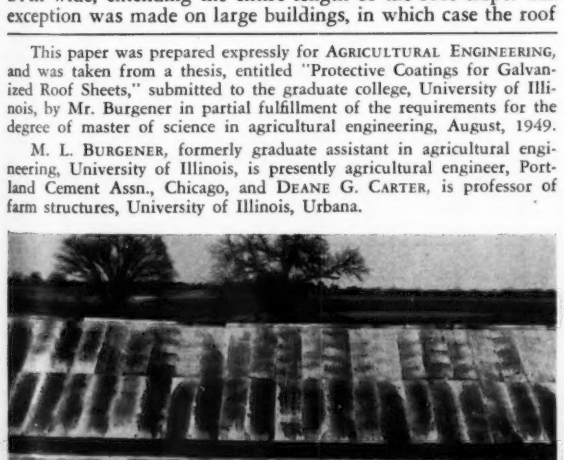


Fig. 1 Typical roof area used for testing protective coatings for weathered galvanized sheets. Barn on Harwood farm at Donnellson, Ill.

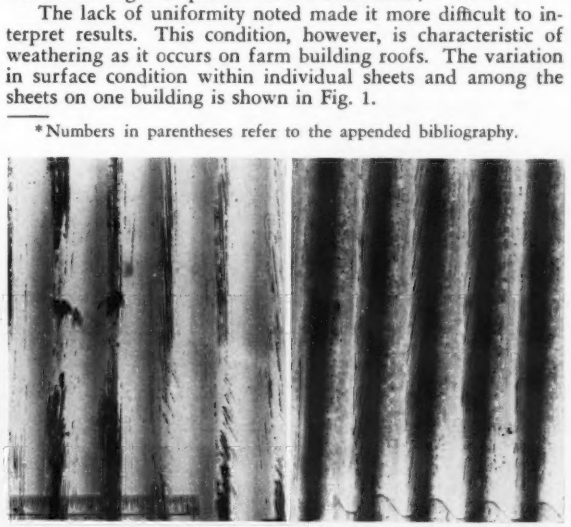


Fig. 2 Test panels after 12-yr exposure. (*Left*) One-coat application of 80 per cent zinc dust, 20 per cent zinc oxide pigment in vehicle composed of 59 per cent linseed oil, 29 per cent soyoil, 7 per cent drier and 5 per cent thinner. Paint film gone from dark areas. (*Right*) Two-coat application. Prime coat principally iron oxide and zinc chromate; second coat two pounds aluminum bronze powder per gallon in vehicle of chinawood oil-phenolic resin varnish. Dark areas show slight rust and exposed prime coat

The tests were limited to some extent because it was not possible to make a large number of replications. Some paints were tested on several specimens (up to 34 in number) while others were applied on only one or two.

Inspection records were made each year by a committee of American Zinc Institute personnel. Since it was not possible to retain the same committee every year, the records naturally reflect differences in the experience and judgment of the observers.

The form of the record emphasizes the need for objective methods of determining paint failure and exact criteria for judgment. In the early reports the breakdown of paint film was recorded qualitatively in such terms as "few pinholes of rust," "incipient rust," or "slight peeling." Further deterioration of the protective coating was indicated by phrases such as "pinholes to definite areas of rust". As the condition of test specimens became increasingly worse, the record indicated the percentage of the paint film which had disappeared. Percentages were determined on the basis of the proportion of the total area of the specimen which was void of paint. Photographs of typical specimens aided in making the calculations.

Criteria for Evaluating Tests. A primary need in connection with paint tests is to decide upon an objective measure of the service life of a paint. Browne(6) lists potential paint users within four categories as those who (a) paint for appearance, (b) paint when the film shows signs of failing but is not badly deteriorated, (c) paint long after the surface should have been recovered, and (d) do not paint at all.

Obviously, each of these groups would have a different idea of the "repaint stage". This stage must, therefore, be defined in order to evaluate paint tests. Singleton(7) states: "To the larger body of technical men who are paint users rather than paint makers, panel tests are only incidental. These men are concerned with the cost and quality of protection which the paint will give on structures in service. The goal of panel testing should not be merely to compare different paint compositions, but to determine the life of the paint on the structure. The result should be a quantitative figure representing the life of the paint system in months or years to the stage where repainting is necessary."

Singleton suggested that the ASTM photographic standards be used to define the repaint stage(7). Specifically ASTM No. 8 was recommended as the repaint stage. By comparison, ASTM No. 7 was suggested as marking the end point in the useful life of a paint. Various authorities assert that failure occurs when rust first penetrates the paint film; others define failure as the appearance of a rust spot of a certain size.

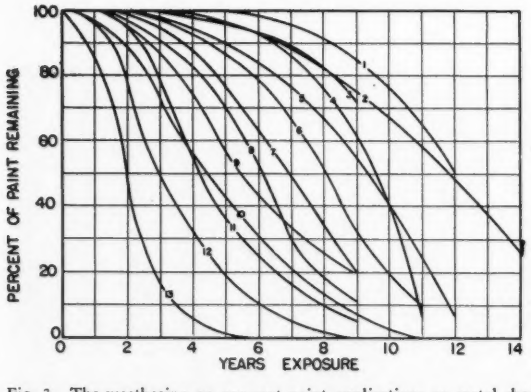


Fig. 3 The weathering on one-coat paint applications on metal sheets for the duration of the test period. Although the "repaint stage" is reached when 5 per cent of the surface of the sheet is exposed, relative performance is best shown by the complete curves. Figures on the curves indicate the paint tested as follows: (1) metallic zinc-60 per cent soyoil, (2) metallic zinc-linseed oil, (3) zinc chromate-iron oxide, (4) metallic zinc-fish oil, (5) metallic zinc-bakelite, (6) iron oxide-linseed oil, (7) zinc dust-zinc oxide-inert (62-18-20), (8) graphite-linseed oil, (9) aluminum-spar varnish, (10) blue lead-linseed oil, (11) red lead-linseed oil, (12) asbestos-asphalt, (13) asphalt

Photographs from the American Zinc Institute tests at Donnellson when compared with the standard ASTM No. 8 showed a close correlation at the point where 5 per cent of the surface was void of paint. Moreover, 5 per cent is a readily visible area. In any event, the more rust present on the sheet, the poorer the performance; and in the tests reported, at least 5 per cent of the paint was gone from most of the specimens at the end of the test period.

For these reasons, an arbitrary value of "5 per cent of the paint film gone" was assumed to define the point at which repainting was necessary. This value was used in reporting the tests. It should be noted that the percentage is based on *surface area* rather than *thickness* of paint film, since the latter would involve measurements difficult to make in the field.

An "average score" method of comparison was also used to evaluate paint failure and to provide a check on the "average years to the repaint stage". This method was proposed and used by Blum, Strausser and Brenner for evaluating metallic coatings for steel(8,9). The method is described by the authors as follows:

"The approximate proportion of the surface rusted was expressed by the scale of ratings shown . . . .

"Each inspector assigned a numerical rating to each specimen, and the average of the ratings of all the inspectors for each set of specimens constituted the recorded rating for that set, location, and inspection date. The mean of this and the rating at the preceding inspection, that is, the average rating for that period, was multiplied by the number of weeks intervening to obtain the 'score' for the period. The total score for the entire period was compared with a perfect score for the same period to obtain the 'percentage score.'

"The net result was to express the quality on a percentage basis, which, however, as shown, is not proportional to the percentage of unrusted surface (see Table 1). In other words, the quality score is not linear with respect to the proportion of rust but is roughly logarithmic."

TABLE 1. RATINGS FOR THE AMOUNT OF SURFACE RUSTED
(After Blum, Strausser, and Brenner)

Surface rusted, per cent	Rating	Corresponding score, per cent	Unrusted surface, per cent
0	5	100	100
0-5	4	80	95-100
5-10	3	60	90-95
10-20	2	40	80-90
20-50	1	20	50-80
50-100	0	0	0-50

Methods of Analyzing Data. Two changes were necessary to fit the Blum-Strausser-Brenner method to the analysis of data in these tests. Since paint on galvanized metal may fail

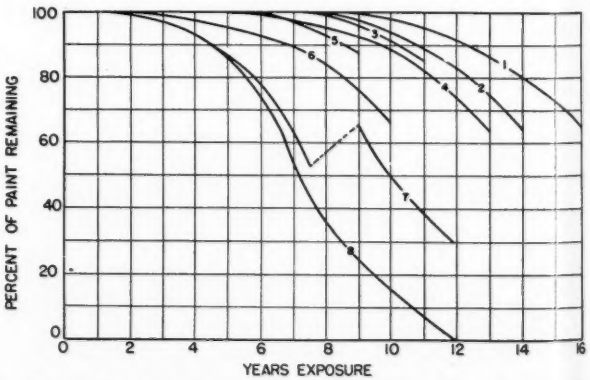


Fig. 4 The performance of two-coat applications in the same series of tests as outlined in Fig. 1. Figures apply to the following paint combinations: (1) spaced coats of metallic zinc-linseed oil, (2) metallic zinc-linseed oil with second coat of aluminum-spar varnish, (3) metallic zinc-linseed oil with second coat of "Dulux" green, (4) both coats metallic zinc-linseed oil, (5) metallic zinc-linseed oil with second coat of aluminum-wood oil resin, (6) metallic zinc-linseed oil with second coat of outside green-linseed oil, (7) both coats aluminum-asphalt, (8) red lead-linseed oil with second coat of outside green-linseed oil

in a manner other than by rusting of the base metal, such as failure due to poor adhesion, the "percentage of film gone" was used instead of "percentage of metal rusted". Also the time between inspections was recorded in terms of years instead of weeks, to coincide with the actual interval. Estimates were made to the nearest quarter-year, however, and all specimens of a particular series were averaged.

Both ratings, that is, *years to the repaint stage* and *average score* were used to state the quality of paint numerically. The relationship between the two may be expressed by the least squares formula, $S = 12.1 + 9.35\ y$, where S = average score and y = average years to the repaint stage. A statistical analysis gave a coefficient of correlation of 0.94, whereas 1.00 is perfect correlation. This suggests that either of the two ratings provides an adequate method for evaluation(10).

Lacking control over numerous variables in a test, the data may be handled in either of two ways: (a) specimens may be grouped in such a way that the effect of any one known variable can be determined, or (b) the specimens in a class may be grouped irrespective of variations, to give an average or "overall" performance result. Sufficient replications were not available in the paint tests to justify analysis by the first method alone. A combination of the two was used here. Thus the average performance was determined in each case and more detailed subdivisions were made where the data permitted. In spite of the limitations in analysis, it is nevertheless possible to compare relative values. For example, the variation in the surface condition of test sheets made it necessary to determine the results on the basis of averages for these varied conditions. Then comparisons for a number of sheets gave an overall average of performance sufficiently valid to predict the "expected life" of the paint. The prediction must be qualified by the influence of the variables that can be evaluated and limited to conditions comparable to those of the tests.

TABLE 2 RESULTS OF DONNELLSON, ILLINOIS, PAINT TEST IN ONE-COAT APPLICATIONS

	Paint description		Time to repaint stage, years	Percentage score	Number of specimens
	Pigment	Vehicle			
1	80% zinc dust 20% zinc oxide	57% soybean oil 29% linseed oil 14% thinner and drier	6.81	79.0	4
2	80% zinc dust 20% zinc oxide	84% soybean oil 16% thinner and drier	6.11	74.9	7
3	80% zinc dust 20% zinc oxide	Fish oil	6.06	66.0	4
4	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier	5.63	68.9	34
5	80% zinc dust 20% zinc oxide	29% soybean oil 59% linseed oil 12% thinner and drier	5.56	66.8	4
6	Lead chromate	Linseed oil	5.45	61.0	4
7	85% iron oxide 15% zinc chromate	Linseed oil	4.88	69.5	4
8	74% zinc dust 19% zinc oxide 7% flake aluminum	71% linseed oil 29% drier	4.33	58.0	3
9	66% zinc dust 16% zinc oxide 18% iron oxide	90% linseed oil 10% thinner and drier	4.20	54.2	5
10	80% zinc dust 20% zinc oxide	70% bakelite varnish 30% mineral spirits	3.93	54.8	19
11	Iron oxide	Linseed oil	3.75	54.0	5
12	50% zinc chromate 50% iron oxide	85% phenolic resin varnish 15% mineral spirits	3.25	46.0	4
13	62% zinc dust 18% zinc oxide 20% inerts	50% linseed oil 40% kettled oil 10% thinner and drier	3.00	39.8	4
14	Graphite	Linseed oil	2.85	38.6	5
15	Zinc dust Zinc oxide Carbon black	90% linseed oil 10% thinner and drier	2.50	31.7	6
16	Red lead Iron oxide Inerts	Wood oil Synthetic resin	2.40	36.4	5
17	Red lead	Linseed oil	2.38	26.0	4
18	Iron oxide Inerts	Fish oil	2.20	28.2	5
19	Aluminum	Bakelite	2.06	29.5	4
20	Aluminum	Wood oil resin	2.00	27.0	3
21	Aluminum	Asphalt	1.64	25.6	11
22	Blue lead	Linseed oil	1.62	25.7	4
23	Copper dust		1.62	23.2	8
24	Asphaltum with asbestos fiber		1.56	16.0	4
25	Outside green house paint		1.50	25.0	4
26	Asphaltum		1.12	14.0	4
27	Zinc flake	Alkyd resin	1.00	24.7	3
28	Blue lead	Fish oil	0.83	9.7	3

Test Results. Tables 2 and 3 and Figs. 3 and 4 give the results of the principal paint tests made at Donnellson, Ill. Although the project extended over a 16-year period, most of the individual tests were completed within 10 yr. For this reason the results are based on a 10 yr duration for the specimens used. The percentage score may be interpreted on the basis of 100 per cent for complete protection for a 10 yr period. The years to the "repaint stage" represents the time for 5 per cent of the paint film to disappear, averaged for the number of specimens in each group or series.

Although well over 400 specimens were analyzed and reported, the tables include only the paint combinations tested on three or more panels. The complete record, including brand names of the products, is on file with the American Zinc Institute and the Illinois Agricultural Experiment Station.

From comparisons made on only one or two panels included for checking, it was concluded that little or no benefit could be gained by painting rusted metal with white lead and oil, ready-mixed house paint, low-quality barn paint, or aluminum paint in a single coating without primer.

It is apparent that certain paints and paint combinations available from 1932 to 1938 might be supplanted today by newer products of much better quality. Moreover, some compositions shown to be relatively ineffective in these tests would doubtless show better performance under other conditions, as, for example, in two-coat work with suitable primers.

Continued test work is essential to determine the answers to many questions. From experiences gained in analyzing this series of tests, a comprehensive new series was established at the Illinois Agricultural Experiment Station in 1948. The new series includes a wide range of old and new products in various coatings and combinations and provides for ample checks, duplications, and uniform exposure conditions.

CONCLUSIONS

Among the general conclusions drawn from the study, the following are most significant:

1 The more rust on the base metal when painting was done, the less durable the coating.

2 Paint wore out faster on the southern and western exposures than on the northern and eastern, due to the effect of the sun's rays.

3 A more expensive, more durable paint is usually more economical than a less expensive, less durable one since the application cost is a major expense of painting.

4 Two coats assure better coverage and generally better results than one-coat applications if the base metal is quite rusty.

5 Paints with oil-type vehicles gave better results as primers than those with varnish vehicles. The varnish-base paints were generally effective as topcoats, however.

6 It is doubtful if wire brushing, as it is done on the farm, is economically justified. However, when wire brushing is not done, much more paint may be necessary to secure good coverage.

TABLE 3 RESULTS OF DONNELLSON, ILLINOIS, PAINT TESTS IN TWO-COAT APPLICATIONS

		Paint description		Time to repaint stage, years	Percentage score	Number of specimens
		Pigment	Vehicle			
1	(a)*	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)*	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier	11.11†	98.9	8
2	(a)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)	Aluminum	Spar varnish	9.00	94.3	3
3	(a)	50% iron oxide 25% zinc chromate 5% zinc oxide 20% inerts	Chinawood oil Phenolic resin varnish			
	(b)	Aluminum	Chinawood oil Phenolic resin varnish	8.58	92.3	3
4	(a)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)	85% chromic oxide 15% zinc oxide	Alkyd resin	8.50	92.7	3
5	(a)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier	8.02	88.4	13
6	(a)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)	Aluminum	Wood oil resin	7.75	88.0	3
7	(a)	80% zinc dust 20% zinc oxide	90% linseed oil 10% thinner and drier			
	(b)	Outside green paint		5.40	63.4	5
8	(a)	Aluminum	Asphalt			
	(b)	Aluminum	Asphalt	4.25	51.3	8
9	(a)	Red lead	Linseed oil			
	(b)	Outside green paint		3.67	52.5	3

*(a) first coat; (b) second coat.

† Second coat applied after first coat had weathered until breaks appeared in the surface.

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Sugar Cane Harvester

(Continued from page 66)

roll. Power from a front power take-off on the tractor operates the cross conveyor. The complete machine weighs approximately 25 tons, about half of which is the weight of the tractor. Approximately 3½ tons of the total weight is carried on the pneumatic-tired outboard wheel. It is interesting that the side draft of this arrangement has been negligible except under very adverse conditions.

In transporting the machine on public highways it is desirable to reduce the over-all width. This is accomplished by dropping off the elevating conveyor and folding the cross-conveyor. A second wheel and a tongue are added to the elevating conveyor and it is towed as a two-wheel trailer.

This machine, which is usually referred to as a cutter-windrower, has been operated over a wide range of conditions. Under the more favorable conditions the production was gradually improved until 40 to 42 tons of net cane were cut and windrowed per hour. A good ground speed has been 2¼ mph for most conditions. With the better conditions the ground speed has been increased to 3¼ mph. With sloping terrain, extreme grades and unfavorable ground surface conditions such as occur with rocks, lower speeds are necessary.

Satisfactory operation was possible up grades of 32 per cent, down 15 per cent grades, and on side slopes of 20 per cent. The cane yields in which the machine was operated ranged from 55 to 150 net tons per acre. Generally the light-tonnage cane gave more trouble because of the high percentage of straight, erect stalks and the scarcity of recumbent, tangled stalks. Since there are no cross slats between the conveyor chains, the straight stalks tend to accumulate lengthwise between the chains unless there are enough stalks crossways to keep the straight stalks moving.

There has been considerable work done in the industry to determine cane damage and sugar losses in the different harvesting and cleaning operations. One test indicated that this machine cut and windrowed cane with a total damage of 2.1 per cent. The best work done before with other machines was 8.6 per cent total damage. These percentages indicate the amount of cane stalk damage by length measurements and are not a measure of the sugar lost. The amount of sugar lost because of stalk damage depends on environmental factors and the elapsed time between damage and milling.

Since this principle of cutting and picking up the cane has been proved, other possibilities have become apparent. The possibility of adapting this type machine to operation in irrigated conditions has become feasible. Principles of dry cleaning and trash removal have been developed in the agricultural engineering department for field cleaning of cane. It appears possible to adapt some of these trash removal principles to the cutter-windrower. Along with trash removal there is the possibility of further development of infield transport so that the cane would be cut, picked up, partially detrashed, and loaded into the transport units for delivery to the mill. Then the machine would be a full-fledged harvester.

Alcohol-Water Injection for High Compression Tractor and Automobile Engines

By J. C. Porter, M. M. Gilbert, H. A. Lykins, and Richard Wiebe

THE tendency towards higher compression ratios in automotive engines has been steady except during World War II. Even then its interruption was only for the simple reason that no passenger cars were being manufactured. The compression ratio has risen from an average of 5:1 in 1930 to one of 6.87:1 in 1949. Individual engines currently have ratios as high as 7.25:1 and optional heads of still higher compression ratios may be obtained from the manufacturer(1)*. A brief announcement(2) lately indicates that the "compression ratio race" is continuing, striving to reach a possible maximum of 8:1 in 1950.

Fuel Economy, Other Factors. The question naturally arises, why are compression ratios going up? The answer is provided in Table 1, showing that thermal efficiency increases with compression ratio. The data were calculated from the equation:

$$\text{Efficiency} = 1 - \epsilon^{(1-k)}$$

where ϵ is the compression ratio and k the ratio of the specific heats C_p/C_v. For the latter ratio, values of 1.246 suggested by Lichty(3) and 1.21 used by Campbell, Caris, and Withrow(4) and others, were taken.

It will be noticed that the relative improvement is affected but slightly by the value of the exponent, and in any case it is the relative increase in efficiency which is of principal interest to us. Absolute thermal efficiency values as computed in either instance are not entirely accurate because of the underlying assumption in the derivation of the equation and the subsequent substitution of a more realistic average value for the ratio of the specific heats. More accuracy in determined values may be obtained by means of calculations such as those published by Hottel, Williams, and Satterfield(5) for hydrocarbon fuels, and by Wiebe, Shultz, and Porter(6) for alcohol.

This theoretical increase in fuel economy has been found by many investigators(7, 8) to be closely attainable, and it is also evident from the results of the tractor tests presented here.

TABLE 1. INCREASE IN THERMAL EFFICIENCY WITH COMPRESSION RATIO

	Where $k=1.21$		Where $k=1.246$	
Compression ratio	Thermal efficiency, per cent	Relative increase in thermal efficiency, per cent	Thermal efficiency, per cent	Relative increase in thermal efficiency, per cent
5:1	28.7		32.7	
6:1	31.4	9.4	35.6	9.0
6.87:1	33.3	16.1	37.8	15.5
8:1	35.4	23.4	40.1	22.5
10:1	38.3	33.7	43.1	31.7
12:1	40.7	41.8	45.7	39.9
14:1	42.6	48.4	47.8	46.0
16:1	44.1	53.9	49.4	51.2

The figures in Table 1 indicate that the gain in thermal efficiency is becoming smaller at the higher compression ratios, but that the limit will be set rather by the economics of manufacture and by fuel availability. Incidentally, there are concomitant benefits arising from increases in compression ratios not shown in the thermodynamic analysis, such as the possibility of using leaner mixtures at part throttle and lower axle ratios for the same performance because of higher output.

Higher compression ratios require higher octane fuels. The purpose of alcohol-water injection is to provide a means for satisfying engine demand for better fuels without increasing the octane number of the fuel. Why further increases in octane number may be undesirable has been shown in a previous publication(9).

Alcohol-Water Injection, Octane Ratings. The principle of applying alcohol-water injection is very simple and although discussed in detail in the publication just referred to, a brief explanation is in order. Over most of the part-throttle range, the octane requirements of present-day automotive engines are low, usually much lower than the octane value of the gasolines on the market. This is because, at part throttle, the engine is actually operating at a lower compression ratio. Most vehicles, except possibly heavy trucks, use the full octane value of their fuel for only a fraction of the time. The fuel provided, of course, must satisfy the octane requirement of the engine and give knock-free performance over the whole range of load conditions encountered. The fuel may not do this, however, for an appreciable number of present-day cars, as found in a recent survey(10). It is shown there that

Primary reference fuel octane number	Per cent of cars having requirements equal to or lower than given octane number
75	18
80	42
85	75
90	97

The Bureau of Mines for the Chicago area(11) indicate average octane ratings are 79.2/74.6† for regular gasoline and 84.6/79.1 for premium gasoline. Even if the research method could be accepted (which in present-day cars is not quite correct), it is obvious that with the premium-grade gasoline in this section of the country the spark setting would have to be retarded in 25 per cent of the cars to prevent knock. The octane number of gasoline has been increased slightly since the issue of the Bureau of Mines report, and the average is distinctly higher in other sections. It still means, however, that regular grades do not give knock-free operation in a large number of present-day cars.

With alcohol-water injection, however, regular or even a lower octane gasoline could be used in all cars satisfactorily. This may be accomplished by an auxiliary device controlled by a manifold vacuum for injecting a mixture of alcohol and water at a time when the extra octane is needed. Such devices have been described extensively in recent publications, (12, 13, 14, 15, 16, 17, 18) and a complete review of past literature is found in another recent publication(19).

That alcohol-gasoline mixtures have a very high octane rating is shown in Table 2. The five experimental base gasolines may be considered as possible representatives of present-day gasolines and it is evident that the response of the research octane number, particularly to the addition of alcohol and in most cases of alcohol and lead, is very good.

The results shown in this table were obtained with blends;

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The authors: J. C. PORTER, M. M. GILBERT, H. A. LYKINS, and RICHARD WIEBE are members of the research staff of the motor fuels evaluation division, Northern Regional Research Laboratory, U. S. Department of Agriculture, Peoria, Ill.

* Numbers in parentheses refer to the appended bibliography.

† This nomenclature is used to designate the "research method" (ASTM D908-48T) and the "motor method" (ASTM D357-48) octane numbers, respectively. At present these methods are the two official tests for the determination of the knock characteristics of motor gasolines. Just how these methods reproduce the behavior of the gasoline in a car is given in the text.

however, they are equally applicable to injection because blending takes place in the manifold during injection.

As shown in Tables 3 and 4, addition of water generally increases the injection requirement, though in amounts up to 15 per cent this increase if often slight. In certain special cases, injection of even 50:50 mixtures may possibly prove to be an advantage where the cooling factor predominates, such as in heavy-duty truck operation and where the difference between the octane requirement of the engine and the base fuel is not too large. These tables will be discussed in more detail presently.

The designation "iso + 0.3" in Table 2 means that the fuel rating is equivalent to iso-octane containing 0.3 ml TEL per gal, a rating beyond the octane scale. On the latter scale, iso-octane equals 100 with n-heptane as zero. The octane number of a gasoline (fuel) is defined as the percentage by volume of iso-octane, in a mixture of iso-octane and n-heptane which will give the same knock intensity as the gasoline (fuel) if rated by one of the standard methods. Strictly speaking, octane numbers above 100, therefore, have no meaning since the concentration of iso-octane in the mixture cannot exceed 100. Scales which include fuel ratings above 100 have been proposed(20) and suggestions have been made for extrapolating the present octane scale(21).

Evaluating Octane Ratings on the Road. That two laboratory methods are in use for the determination of the knock characteristics of motor fuels introduces some confusion, since the question arises as to which or what combination will tell us how the fuel behaves in the car. For the purpose of establishing a relationship between laboratory and road behavior of fuels, two road-rating methods, the "Modified Uniontown" and the "Borderline" (22, 23, 24), are most commonly used at present. Essentially, the two methods are based on the ability of the fuel to tolerate spark advance. The road octane number is obtained by bracketing with reference fuels and by interpolation. In the Uniontown method, the comparison of the knock characteristics of the test fuel with reference fuels is made at the point of maximum knock during full-throttle operation, regardless of engine or car speed. In the Borderline procedure, the car (or engine) is accelerated from a very low speed with wide open throttle at a fixed spark setting, and the speed is noted at which the knock dies out. Even though the Uniontown method gives data for one speed only, it usually provides enough information regarding the ability of the fuel to give knock-free operation over the whole speed range.

Ordinarily the Borderline ratings of gasolines decrease with increased engine speed and the Research and Motor method octane numbers are an indication of their low and high-speed ratings, respectively. As shown in Table 2 the road

TABLE 3. ALCOHOL INJECTION REQUIREMENTS FOR A MINNEAPOLIS-MOLINE TRACTOR ENGINE

Compression ratio, 8:1; speed, 1250 rpm; spark advance, 19 deg; full throttle; octane requirement, 95

Alcohol mixture per cent by volume	Ratio of alcohol mixture to base fuel for trace knock, in per cent by weight: Base fuel: Premium gasoline 86/81octane	Base fuel: Reference fuel 85 octane
Ethanol	28.1	21.4
Ethanol-water 85:15	29.6	21.8
Ethanol-water 50:50	39.0	25.7
Methanol	27.3	20.2
Ethanol-methanol 50:50	27.2	20.7
Ethanol-methanol (50:50) and water 85:15	27.6	22.7
Isopropanol	37.4	30.0
Ethanol-isopropanol (50:50) and water 85:15	33.5	31.4

TABLE 2. KNOCK RATING OF ALCOHOL BLENDS

Fuel description, per cent by volume of each	Octane numbers: Research Method	Motor Method	Modified Uniontown method: Oldsmobile C.R.10:1	Plymouth C.R.6.6:1	Borderline method, Plymouth C.R. 6.6:1: 750 F.P.M.	1000 F.P.M.	1500 F.P.M.	2000 F.P.M.	2500 F.P.M.	3000 F.P.M.
25% Tol.* – 75% 63 octane reference fuel	78.2	73.8		81.0	-	78	81	78	76	74
25% Tol. – 75% 63 octane reference fuel + 1 ml. T.E.L.	88.3	84.4		87.0	87	87	90	-	-	-
+ 10% ethanol	87.1	80.0	87.7	86.5	87.5	88.5	87.5	85.5	82.5	79
+ 10% ethanol + 1/2 ml. T.E.L.	92.2	84.5		91.2						
	92.2	84.8	91.0	90.7	92.5	92.5	91	88	85.5	83
+ 10% ethanol + 1 ml. T.E.L.	94.8	88.1	93.0	93.5	94	94	91.2	89 est.	-	-
	94.9	88.1	93.2							
+ 10% ethanol + 2 ml. T.E.L.	97.4	89.5	97.7							
+ 25% ethanol	97.2	86.4		96.3						
	97.5	86.6	98.2							
+ 25% ethanol + 1 ml. T.E.L.	iso + 0.1	88.9	iso + 0.3							
+ 25% ethanol + 2 ml. T.E.L.	iso + 0.21	90	iso + 0.45							
25% Dib.* – 75% 50.4 octane reference fuel	76.1	73.8		76.0	77.5	78	80	79	74.8	73.5
+ 10% ethanol	84.6	79.2	85.6 ?	82.3	-	86	83.5	82.7	81	76
				81.5						
+ 10% ethanol + 1 ml. T.E.L.	92.4	86.2	90.7	90.0	89	87.5	89	87.2	83	81.5
+ 10% ethanol + 2 ml. T.E.L.	95.6	87.4	94.0	92.0	93.5	92	89	87.5	84	81.5
				92.5						
+ 25% ethanol	95.2	85.0	97.5							
+ 25% ethanol + 1 ml. T.E.L.	98.5	87.0	iso + 0.03							
+ 25% ethanol + 2 ml. T.E.L.	98.8	88.1	iso + 0.05							
50% Tol. – 50% 45 octane reference fuel	84.3	74		85.5	-	85.0	85.5	83	80	77
+ 10% ethanol	90.1	79.5	90.0	90.6	93	92.5	88.5	86.5	84.5	81
+ 10% ethanol + 1 ml. T.E.L.	97.3	85.6	97.8	98.0	98.0	97.5	95.0	91.5	87.0	84.5
+ 10% ethanol + 2 ml. T.E.L.	99.2	87.1	100							
+ 10% ethanol + 3 ml. T.E.L.	100	90.2	iso + 0.1							
+ 25% ethanol	97.5	84.6	iso + 0.1							
+ 25% ethanol + 1 ml. T.E.L.	iso + .24	86.7	iso + 0.4							
+ 25% ethanol + 2 ml. T.E.L.	iso + .34	87.1	iso + 0.5 est.							
+ 25% ethanol + 3 ml. T.E.L.	iso + .3	89.1	iso + .4							
50% Dib. + 50% 15 octane reference fuel	82.4	74		77.5	85	83	81	80.5	75	72.5
+ 25% ethanol	95.0	81.8	95.5	91.3	-	90.5	87.5	85	81	75.0
+ 25% ethanol + 1 ml. T.E.L.	99.0	82.6	98.5							
+ 25% ethanol + 2 ml. T.E.L.	99.3	84.1	100							
50% (50% Tol. + 50% Dib.) + 50% 1° octane reference	79.4	70.2		78.5	80.5	80.5	80	75.5	74	73.2
+ 10% ethanol	85.4	76.1		84.0	86	85.5	84	81	77	73.5
+ 10% ethanol + 1 ml. T.E.L.	92.7	81.6	90.0	90	89	89	87	84.5	81	76
+ 10% ethanol + 2 ml. T.E.L.	94.5	83.2	94.0	93.0	93.7	92	88.5	86.5	82.5	80.5
+ 25% ethanol +	94.2	81.1	95.0	91.5	-	91.0	87.5	85	83	76 est.
+ 25% ethanol + 1 ml. T.E.L.	98.3	82.9	98.9							
+ 25% ethanol + 2 ml. T.E.L.	99.5	84.8	99.8							

* Tol. = toluene; Dib. = diisobutylene

TABLE 4. ALCOHOL INJECTION REQUIREMENTS FOR A GENERAL MOTORS HIGH-COMPRESSION TEST ENGINE (HC-125)

Compression ratio, 10:1; speed, 1000 rpm

Alcohol mixture, per cent by volume	Ratio of alcohol mixture to base fuel for trace knock, in per cent by weight								
	Base fuel: reference fuel, 85 octane			Base fuel: premium grade gasoline, 86/81 octane			Base fuel: experimental gasoline, 91/82 octane		
	Full throttle	Manifold vacuum 4 in	Manifold vacuum 6 in	Full throttle	Manifold vacuum 4 in	Manifold vacuum 6 in	Full throttle	Manifold vacuum 4 in	Manifold vacuum 6 in
Octane requirement	100	97	94	100+	98	95	100	97	94
Ethanol	20.0	17.6	11.6	57.1	29.5	23.4	11.5	7.2	5.1
Methanol	20.5	17.2	15.6	56.1	26.5	19.8	15.8	7.9	6.3
Ethanol-methanol 50:50	19.3	15.6	15.3	46.5	26.1	27.0	17.1	13.2	8.4
Ethanol-methanol (50:50) and water 85:15	24.3	15.6	12.7	63.0	34.0	20.4	16.7	11.6	5.7
Isopropanol	26.8	19.4	14.7	57.2	34.6	27.0	19.2	14.6	7.6
Ethanol-isopropanol (50:50) and water 85:15	26.6	21.0	15.0	60.6	36.9	30.0	19.9	10.9	7.3

ratings of the "25% Tol-75% 63 octane reference fuel" at 1500 and 3000 rpm of 81 and 74 are in general agreement with the laboratory octane numbers of 78.2 and 73.8. For the same reference fuel blended with 10 per cent ethanol, the same conditions prevail closely. In both cases the highest low-speed road ratings exceed the Research octane number, and this appears to be generally true for the remaining reference fuels and their blends. This is not true, however, at high speeds where the Motor method values may either exceed slightly the Borderline results or at times fall considerably below these ratings. A low-compression engine, as the one used for obtaining the data, is not very suitable for rating high-octane gasoline and their blends. The study is being continued in high-compression engines and with a greater variety of fuels.

From Table 2, two interesting conclusions may be drawn: (a) that maximum octane requirement is in better agreement with the Research method octane number than with that of the Motor method and (b) that the agreement is even better at higher compression ratios. For straight hydrocarbon fuels, similar conclusions had been drawn previously(4, 25, 26, 27).

Neither the Uniontown nor the Borderline method takes into account the distributor spark advance of the engine at full throttle nor gives data at part throttle. The next step, therefore, is the correlation of engine octane requirements with fuel-knock characteristics which is shown in Figs. 1, 2, and 3A for three engines: a Minneapolis-Moline tractor engine with 8:1 compression ratio, a General Motors high-compression test engine with a 10:1 ratio and a 1946 Ford V-8 engine with a high-compression head of 8.25:1 ratio. These curves were obtained with the primary reference fuels, iso-octane and n-heptane. Superimposed on the octane requirement frame work in Fig. 2 is a curve representing the behavior of a fuel having a 91/82 rating. The results check the previous statement that in high-compression engines the Research rating is a better criterion of the fuel's behavior in the engine than the Motor method. It is obvious that a fuel having octane numbers of 91/82 would knock severely at full throttle except at 3000 rpm.

At 4-in manifold vacuum, knock would die out at 2100 rpm and at 6-in vacuum no knock would be experienced above 1500 rpm. How much injection is necessary at the point of maximum knock (1000 rpm) for this engine is shown in Table 4 for three base fuels. The lower the octane number of the base fuel, the higher the rate of injection. The proper rate will depend on the economics of the case. The premium-grade gasoline of 86/81 octane number would hardly be suitable, but one equal to the octane number of the experimental gasoline (91/82) could be used since the injection ratio is very low. To avoid any confusion, the actual consumption of an alcohol mixture will depend entirely on driving conditions, but in ordinary city and country driving, injection may be required only for a small portion of the time. An idea of this may be obtained from Figs. 3B and 4 where the ratio of alcohol mixture to fuel in per cent by weight is given as a function of manifold vacuum. Results of driving tests for the General Motors high-compression test engine will be published at a later date; however, test results on several other cars will be found in publications cited previously (9, 12, 13, 14, 16, 17, 18).

Effect of Mixture Composition on Injection. The efficiency to suppress knock is about the same for ethanol and methanol, as shown in Table 3, and the addition of 15 per cent of water appears to make little difference in the amount needed. Exceptions to this, however, are found in Table 4. Results of Table 4 were obtained at different times and it will be noticed that the octane requirement did not remain constant. Accumulation of carbon up to a certain point will raise the octane requirement. Different engines will require different amounts for the same octane gains (octane requirement of engine minus the octane number of the base gasoline), though in most cases this difference will be slight. This difference in behavior is found equally in their response to the same gasolines.

How the addition of tetraethyl lead reduces injection required to prevent knock is illustrated in Fig. 5. Results are shown for three base fuels, an 85-octane reference fuel (85 per cent iso-octane and 15 per cent normal heptane), a premium grade fuel of 86/81 octane number, and for an experimental blend (diisobutylene-toluene mixture blended with reference

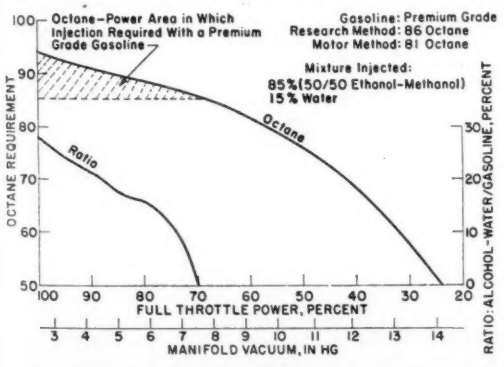

Fig. 1 Octane requirement and required injection ratio for trace knock vs. per cent power or manifold vacuum (throttle setting) for a MM-UTS tractor with 8.0:1 compression ratio and with a premium-grade gasoline. Speed: governor controlled, 1250 rpm at full throttle; spark advance: 19 deg BTDC; A/F ratio: 14-15:1

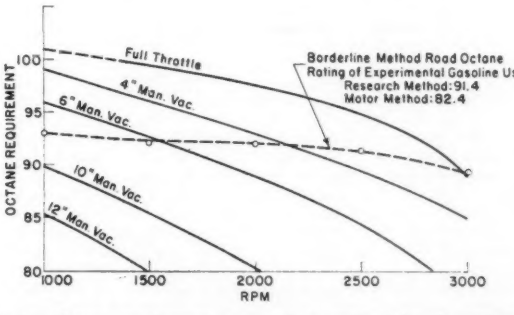

Fig. 2 Octane requirement vs. speed at various throttle settings as obtained on a chassis dynamometer for the General Motors high-compression test engine with 10:1 compression ratio installed in a "98" Oldsmobile. Distributor type: X-20071; initial spark advance: 5 deg BTDC; spark advance automatic and advance curve within manufacturer's limits; carbon miles: 3212

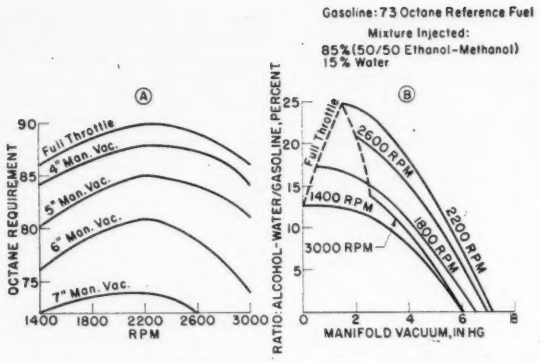

Fig. 3 (A) Octane requirement vs. speed at various throttle settings as obtained with a 1946 Ford V-8 engine with 8.25:1 compression ratio and initial spark advance of 4 deg BTDC. Spark advance automatic. (B) Required injection ratio vs. manifold vacuum (or throttle setting) at various speeds for the same engine

fuel) of 91/82 octane number with injection of three antiknock agents: ethanol, methanol, and 85:15 (50:50 ethanol-methanol)-water mixture. In this case, ethanol is superior to the 85:15 mixture and even to methanol with the special blend as base fuel, though ordinarily the difference between ethanol and methanol is slight and may vary either way (see Tables 3 and 4).

As also shown in Fig. 5, injection rates (ratio of antiknock mixture to gasoline in per cent by weight) and effect of lead for both ethanol and methanol were identical with the 85-octane base fuel. Full throttle data for the 86/81 base fuel are beyond the range of the plot (Table 4). However, part-throttle data at 4 and 10 in of vacuum are given.

Tractor Fuel Economy. The beneficial effects of increase in compression ratio on fuel economy may be noted in Fig. 6 where hp-hr per gal is plotted against compression ratio. The greatest gain is the full-load range, but even at a 1000 lb pull a saving of 15 per cent is possible. In Fig. 7A specific fuel consumption (lbs per hp-hr) and manifold vacuum are given as a function of per cent load when 100 per cent load is that obtainable with the 5.3 compression ratio head. As indicated, an additional 30 per cent in power may be obtained at 8:1 compression ratio using a premium gasoline as base fuel and a 28 per cent injection ratio of 85:15 alcohol-water mixture to gasoline at full throttle. Similar data are plotted for 6.8:1 compression ratio. Range of injection is between approximately 8 in of manifold vacuum to full throttle and is also shown by the shaded area in Fig. 1, upper curve.

The possible gain in specific fuel consumption is illustrated better in Fig 7B, using the same coordinates but with 100 per cent load, being the maximum power obtainable, with each of

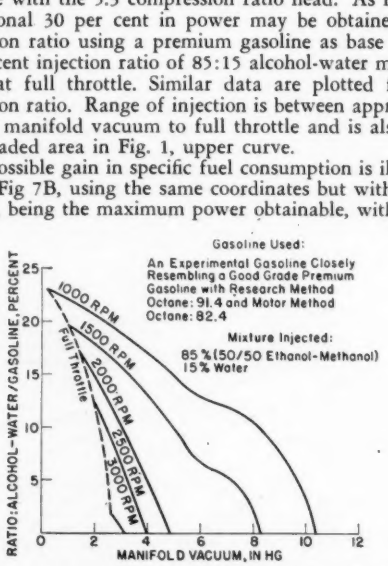

Fig. 4 Required injection ratio vs. manifold vacuum (or throttle setting) at various speeds as obtained on a chassis dynamometer for the General Motors high-compression test engine with 10:1 compression ratio installed in a "98" Oldsmobile. Distributor type: X-20071; initial spark advance: 5 deg BTDC; spark advance automatic and advance curve within manufacurer's limits; carbon miles, 3880

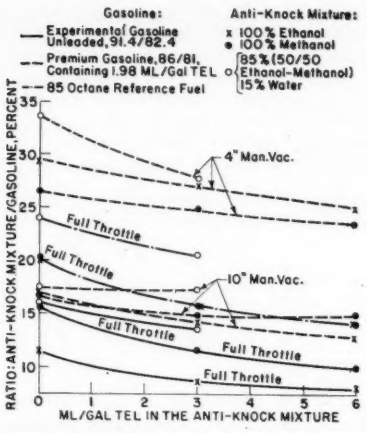

Fig. 5 Effect of tetraethyl lead in antiknock mixture on required injection ratio. Chassis dynamometer results obtained at 1000 rpm with a General Motors high-compression test engine with 10:1 compression ratio installed in a "98" Oldsmobile. Spark advance automatic and advance curve within manufacturer's limits

the three compression ratio heads. In other words, at 100 per cent load, the tractor engine with a 8:1 head will produce 30 per cent more power (Fig. 7A) than the one with a 5.3:1 head, and the possible gain indicated can be achieved only if the tractor is pulling a proportionately higher load. This applies equally to all curves shown.

Leaner mixtures may be used in higher compression engines, both because there is less dilution with exhaust gases at part throttle and because more excess power will usually be available to sacrifice peak power. The relationship between full-throttle horsepower, specific fuel consumption, and air-fuel ratio is shown in Fig. 8.

SUMMARY

The trend towards higher compression ratios raises the problem of obtaining better fuels. It is shown that even for compression ratios considerably beyond the present range, a good grade present-day premium gasoline in combination with alcohol-water injection would give knock-free performance. This would apply equally to tractor, truck and automobile engines.

Even today, premium-fuels do not satisfy the specified octane requirements of all cars. The percentage will vary considerably with the particular section of the country. Spark setting may be retarded in many cases with only a slight reduction of performance, however, alcohol-water injection would permit maximum power spark advance.

Higher compression ratios give better fuel economy which would be of importance to farmers and commercial operators. The average motorist is interested mainly in "pickup", which would be improved by a more powerful engine. In both cases, therefore, alcohol-water injection would have its place.

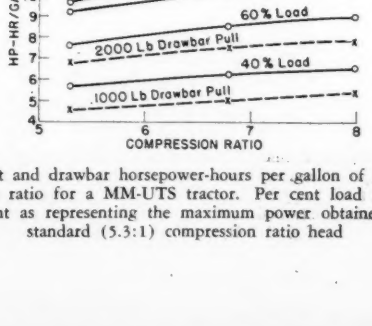

Fig. 6 Belt and drawbar horsepower-hours per gallon of gasoline vs. compression ratio for a MM-UTS tractor. Per cent load is based on 100 per cent as representing the maximum power obtained with the standard (5.3:1) compression ratio head

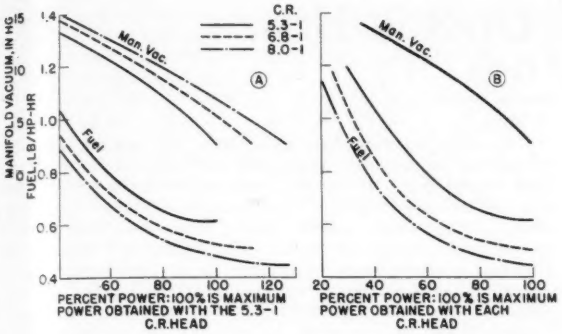

Fig. 7 Specific fuel consumption and manifold vacuum (throttle setting) vs. per cent power at governed speed for MM-UTS tractor. Mixture injected: 85 per cent ethanol-methanol (50:50) and 15 per cent water.

C.R.	Sp. adv., deg	A/F ratio	Gasoline	Injection required at full throttle: alcohol-water to gasoline, %	Manifold vacuum at which injection is required
5.3-1	26	13-14	Regular	....	....
6.8-1	26	14-15	Regular	25	7-8 in mercury
8.0-1	19	14-15	Premium	28	7-8 in mercury

It is hardly necessary to emphasize that there is at present no nationwide distribution system for alcohol-water mixtures, and that any development will proceed slowly.

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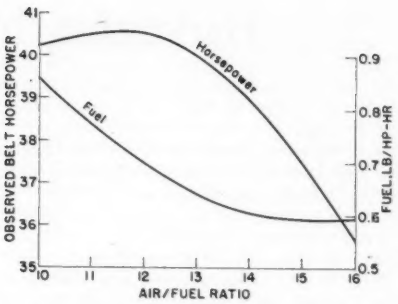

Fig. 8 Belt horsepower and specific fuel consumption as a function of air-fuel ratio for a MM-UTS tractor with 5.3:1 compression ratio and operated at 1250 rpm, full throttle

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Cotton Ginning Research Results

DEVELOPMENT of new improved varieties of cotton which have better spinning properties, longer fibers and other advantageous characteristics has brought great improvement in the growers' products; but a large part of the value of improved crops can be nullified during the few minutes it takes to gin a bale of cotton. A poor job of removing foreign matter, pulling the lint from the seed, packing the lint into bales, and recovering the seed, can produce serious losses to the growers. Price of cotton varies with the length of the fiber, its color, the amount of foreign material in the lint, and physical condition of the lint. Losses resulting from poor ginning even now are estimated at $15,000,000 a year.

Among research findings of the U. S. Department of Agriculture passed on to the cotton industry, in addition to the conditioning and drying of seed cotton previously described, are the following:

Saw Speeds and Seed Rolls: An increase of saw speed from 400 to 600 rpm and ginning with loose seed rolls have increased gin capacity almost 20 per cent on both long- and short-staple cottons.

Saving of Power Waste: Large savings in power — a major item of expense in every cotton gin — have been made from studies that gave ginners improved piping and fans and better methods of operation.

Saw Design: Specific recommendations have been made both as to design and maintenance of gin saws. These are now being followed by all gin manufacturers and by many ginners to eliminate unsatisfactory variation in preparation of ginned lint.

Pure Seed Handling: With improved and standardized varieties of cotton coming into more general use, the engineers have developed handling equipment to prevent mixing of these seed during the ginning process.

Harvesting Napier Grass in Hawaii

By John F. Cykler
MEMBER A.S.A.E.

ONE of the problems of the Hawaiian dairy industry is the high cost of feed and a controlling factor in the cost of Island green forage is hand labor. Green forage is cut, chopped, and fed fresh each day. No green feed is stored since Hawaiian agriculture is practiced the year round. Fields are normally small, rough, rocky, and irregular in shape, and the soil is sticky when wet. Normally the entire field is planted since land values are high and weed growth a problem.

There are two principal green forage crops. The first, koa haole (ekoa, *Leucaena glauca*), has been handled successfully with the corn binder. However, mechanical harvesting of Napier grass (*Pennisetum purpureum*) continues to be a problem. This latter grass outranks all other dairy roughages grown in Hawaii on a green and dry weight basis. The grass grows to a height of 12 to 14 ft and yields up to 40 to 60 tons per acre per cutting. There are normally three to four cuttings per year. Dairy cattle consume 60 to 70 lb per day. The crop is planted in rows 3½ to 4 ft apart using portions of the stalk or root. It stools widely until the area between rows is almost closed. Irrigation is by the furrow method. No waste water ditches are used, which is the general practice with sugar in Hawaii. Over a period of continuous cropping and irrigation the fields become very ridged and rough. Most fields are plowed and replanted every ten years. Labor requirements for harvesting, chopping, and feeding varies between dairies from 2.75 to 9 man-hours per ton. Harvesting and chopping represents from 60 to 70 per cent of the total labor.

Present field-harvesting methods vary, but one generally used method is to cut the standing crop with a 5-ft tractor mower. The grass is then piled into bundles weighing from 35 to 40 lb each and laid out in rows in the field. One dairy uses two crews, one for cutting and the other for chopping. The cutting crew consists of a tractor driver and four men to gather and bundle the grass. A chopper crew of five men with a tractor-drawn, diesel-powered ensilage chopper mounted on a four-wheel trailer moves about the field. Four men pick up the bundles and feed the ensilage chopper while the fifth man acts as operator. The grass is blown into a four-wheel farm wagon which holds 1.75 tons of green chopped forage. This ranch mixes molasses with the grass as it issues from the blower spout.

The experimental project reported in this paper was set up to develop lavor-saving machinery for harvesting and chopping Napier grass. It was proposed to attack this problem by adapting existing trail-type, field-forage equipment to meet the needs of high yields, widely stooled crop, and which would operate over ditches and in fields with relatively short rows and lack of headlands. A review of all likely makes and models of corn ensilage harvesters was made. A No. 2 International Harvester corn field forage chopper was purchased principally because it was the only known forage harvester in Hawaii. This is a trail-type machine without auxiliary power. Preliminary field trials were held January 2, 1948, using a Farmall H tractor in first gear and wide open throttle. Results indicated an inadequate power supply plus choking of the grass in the hopper and spiral feed rolls. Choking also occurred in the feeder trough below the rotary cutting knives. A T-9 tractor was substituted for the Farmall H with the same results. Identical conditions were encountered when operating under a split-row condition which was used to reduce the grass intake to the machine. It was also noticed that the left wheel ran down uncut material and some modification would be needed to rectify this condition.

To study the machine more carefully, a drawing-board analysis was proposed. Physical dimensions, sprocket speeds, and chain speeds were obtained. These data were laid down on the drawing board and the path of a single rigid stalk of Napier grass was plotted through the machine assuming the harvester at two different field speeds. (Fig. 1). Very definite conclusions were obtained from this analysis. Following is a summary of these results.

Three elevator chains are used on this harvester. The top chain is called the gatherer chain and the lower two chains are called the upper and lower butt chains. A differential speed exists between the top and lower chains. The gatherer chain engages the stalk 19 in horizontally before cut by the sickle and engaged by the butt chain. This takes 0.41 sec in first gear and 0.21 sec in fourth gear. Here is the critical point in the analysis. In first gear and in 0.41 sec the stalk has traveled 21 in out of the total 57 in along the gatherer chain before the butts are cut and engaged by the butt chains. The stalk at this position tilts forward about 6 deg. The remainder of the stalk travel takes 0.69 sec before the gatherer chain lugs discharge the stalk to the spiral feed rolls. However, in 0.69 sec the butts still lack 3.75 in of travel before they are clear of the butt pan and released by the butt chains to the lower feed rolls. Therefore, in spite of the existing differential speed of the chains and with the tractor in first

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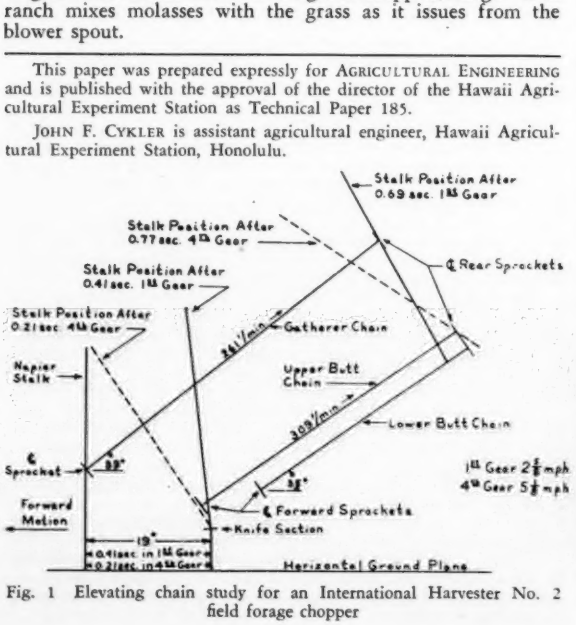

Fig. 1 Elevating chain study for an International Harvester No. 2 field forage chopper

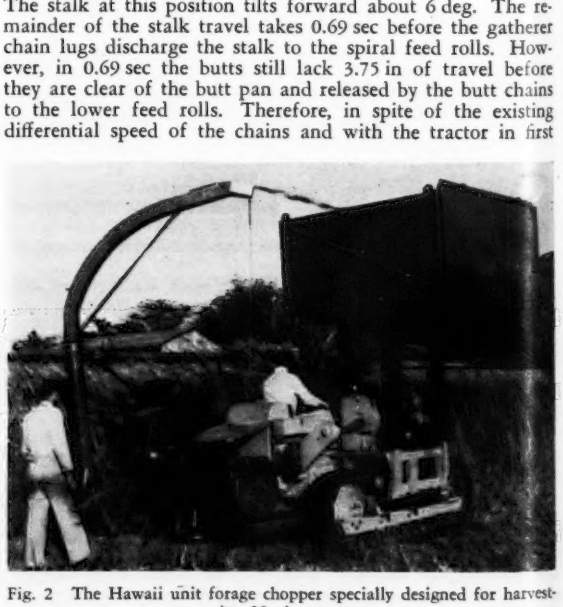

Fig. 2 The Hawaii unit forage chopper specially designed for harvesting Napier grass

gear, the top is released ahead of the butts and the resulting action by the spiral feed rolls is to force the butts back down the butt pan thus choking the hopper and spiral feed rolls with oncoming material.

In fourth gear the gatherer chain elevates the stalk only 11 in along the chain before the butts are cut and engaged by the butt chains. This provides a greater initial tilt and the final result is that the butts are released to the lower feed rolls before the gatherer chain has released the tops. Hence, the butts have been placed at the proper entry angle to the feed rolls and the stalk is fed to the chopping unit without further trouble.

This analysis was proved by further field trials in fourth gear and choke-free operation resulted. With the present rough fields it was almost a physical impossibility to drive the equipment in fourth gear. Many changes took place in the basic machine, but the work ended in a harvester with the following modifications:

1 The left wheel was replaced by a two-wheel truck which was fabricated and bolted to the left side of the axle under and between the left outer and inner angles.

2 The gatherer chain speed was reduced from 261 to 93 fpm and the butt chain speed was reduced from 309 to 133 fpm.

3 A 20-hp auxiliary engine was installed to keep the harvester at full operating speed and independent of the tractor speed.

4 A blower attachment was added and replaced the former paddle-type elevator.

The final machine operated 1 mph (depending upon the wind and field conditions) with a 20-hp auxiliary engine and full cut (23 in), in 15 to 25-ton grass. Extended field trials produced harvesting rates above 3½ tons per hour. With a slow field speed the machinery was able to operate in rough fields without noticeable damage and this speed limited the material intake of the machine to within its capacity.

To increase the general knowledge of the adaptability of various makes of forage harvesters the Waimea dairy on Kauai loaned the University of Hawaii agricultural engineering department a new Fox forage harvester with corn attachment and auxiliary engine. It had the same initial difficulties as the No. 2 I.H.C. harvester. However, with a modification in the chain-drive system for a field speed of 1½ mph and a replacement of the outboard flywheel by a three-wheel pneumatic tire truck secured to the right axle under the chopping unit, harvesting rates of 475 lb per min were easily obtained.

Conclusions. A No. 2 I.H.C. and Fox field forage harvester can be modified to perform a creditable job of harvesting and chopping Napier grass for green forage. Speeds of 1 to 1½ mph should be used to reduce damage to machinery and limit grass intake to the capacity of the machine. Field efficiencies under present agronomic practices will not be much over 40 to 50 per cent. The harvester chopper can be operated by one man. Rough fields cause frequent work stoppages due to breakage of machinery parts.

Track-type tractors should be used under present field conditions of deep furrows and ditches unless mule cleats are used on wheel equipment. Better regulation of cutting is attained by moving the harvester across the rows rather than along the planted row. Horsepower requirements for auxiliary power will depend upon field speed and yield in tons per acre. Twenty horsepower is required for the No. 2 I.H.C. harvester under full-cut conditions at 1 mph in yields of 15 to 25 tons per acre.

Unit Napier Harvester. The dairy industry in Hawaii was still not satisfied with the final outcome of the modified trail-type harvesting equipment. Their main objections were as follows: Trail equipment means a tractor, harvester, and wagon hitched one behind the other. They felt that the fields were too rough and small for such equipment to operate efficiently. Their emphasis was placed on a unit-type harvester which would embody the harvester, storage bin, and propulsion unit in a single machine. With this in mind a unit harvester was designed and assembled from the equipment on hand. The cash outlay for such equipment is high when compared with trail-type harvesters.

A machine of this nature has been assembled using as basic units a T-9 wide-tread, track-type tractor, the modified No. 2 I.H.C. field forage chopper, and a VF-4 Wisconsin engine for an auxiliary power unit (Fig. 2). A steel bin 3½ x 6 x 7 ft was fabricated and mounted overhead on two pin pivots. The bin support is framework bolted to each side of the right track frame. The bottom of the bin is 8 ft 5 in from the ground level. The bin dumps to the right by rotating on these pin hinges and the chopped grass passes through a swinging endgate hinged at the top of the bin frame. The power machinery for dumping was mounted directly below the bin and consists of a rear power take-off and clutch assembly, a reversible gear box, and a winch drum and brake assembly. A wire cable connects the drum to the bin. This cable makes a few turns around the winch drum and secures to two points an equal distance apart and on opposite sides of the bin pivot points on the bin floor frame. To tilt the bin the winch drum takes up on one side of the cable and lets out an equal amount of cable on the other side of the drum. A compression coil spring shock device was installed between the cable and bin to place an initial tension of about 1000 lb on the wire cable to hold the bin against its seat when not in the tilting position. The spring shock device also acts as a safety in case the operator places too heavy a strain on the cable when reseating after dumping.

The harvester unit was mounted on a cantilever beam supported by framing bolted to the left track. Pin hinges connect the harvester to the beam. This method of mounting allows the harvester to pivot only in one plane and is controlled by a mechanical raise-and-lower lever within easy reach of the driver. This lever raises or lowers the harvester to adjust the height of cut and for transport in and out of the fields. The main reasons for restricting motion to one plane was to simplify the machine and lower construction costs. It was felt that the harvester could function properly on one fixed pivot point if the fields could be reworked and and made made reasonably free from deep ditches and furrows. A small auxiliary engine mounted directly behind the tractor drives the harvester.

Much consideration was given to the problem of where to place the bin. The present location was selected to give the driver an unobstructed view, to place the bin high enough to dump directly into a truck or trailer, and finally so as to mount the bin on simple pin hinges.

Another method of dumping should be mentioned. A tractor-engine-driven hydraulic pump combined with double-acting hydraulic cylinders can replace the present power take-off and winch drum assembly for bin dumping and bin door closing. The use of hydraulic equipment is justified as it would simplify construction and save weight. The present dumping system was used since parts were in storage in the shop.

To reduce the possibility of springing the harvester mounting hinges a snubber attachment was fabricated and attached to the forward end of the harvester. This prevents the rotation of the harvester if the gatherer shoes dig into the soil while turning. The harvester also floats to take care of the difference in terrain and relative movements of the tractor and harvester units, and this spring floating mechanism is combined in the raise-and-lower mechanism. Some difficulty was encountered by the reduced capacity of the blower at high rates of chopping. This was rectified by cutting a 6x10-in square hole in the rear sheet cover of the blower. This reduced the suction head on the blower and increased its capacity. No further trouble has been encountered in elevating the chopped feed to the bin.

This harvester operates well under all types of weather. It has done a creditable job under rainy conditions. No detrimental effects of the flat tractor tracks on the growth of subsequent crops has been noticed to date. The machine can be made to cut square corners under continuous one-way operation. It operates both across and along the lines. However, a more even feeding is obtained by cutting across the lines.

Extensive field harvesting has shown over-all harvesting rates of 3.6 tons per hour under *(Continued on page 79)*

Flatland Soil Conservation

By B. A. Myers

FLATLAND soil conservation and its problems evolve mostly around the water; either it is a question of too much water or not enough. Water influences almost everything that we do on flat land as well as on the upland. Cities like Saginaw, Michigan, spend millions of dollars to get fresh water for their own use. Just recently a 48-in line 60 mi long, costing 11½ million dollars, was completed to get fresh water from Lake Huron into Saginaw and Midland. This tremendous job was necessary because of pollution. The river water could not be filtered sufficiently to overcome this. Because of the soil load the water is too thick to drink and too thin to plow. It carries a tremendous amount of soil. This is agricultural pollution and much of the soil comes from flat land. The river is choked with silt; fish and other aquatic life also suffer. River bottoms are raising.

The Saginaw River carries about 43,000 tons of topsoil and suspended material in 24 hr when at flood peak. The Grand River carries somewhere around 50,000 tons of topsoil or suspended material. Because of the decreased river capacities in the Saginaw Valley it is necessary to dike and build levees. However, with the river bottoms rising our dikes are no longer adequate (Fig. 1). Under present conditions we cannot continue to dike unless we begin with the causes and stop the soil from getting into our streams.

We dredge rivers with various types of dredges to clean out soil, sand and other debris when we could do better by holding it back on the land in the watershed. The U. S. Army engineers estimate that in the Saginaw River (between the Court and Bristol Street bridges), a distance of less than one-fourth mile, they will remove 155,000 cu.yd of erosion debris to restore the river channel to its original 16.6-ft depth. This same river was dredged to this depth five years ago. In five years the entire job has had to be done over again to make one-fourth mile of river navigable.

The discharge from this dredging operation is interesting. It runs very black and is high in organic matter. The discharge (Fig. 2) shows that it is almost like activated sludge coming from a sanitary sewage treatment system. This activation aerates the organic matter and absorbs the oxygen from the water which, in turn, kills the fish.

The other partner in our team of soil and water conservation on flat land is the soil itself. Brookston clay loam, as found near Frankenmuth in its original state, contains a high amount of organic matter. The number of bacteria in a cubic inch of this material amounts to about 140 million. There are just about that many people in the United States. These bacteria live on the organic matter, breaking it down and making plant food available to plants. Organic matter acts as an absorbent; it absorbs the rainfall and allows it to pass into the soil, reducing runoff. It is also an equalizer since it keeps the plants from being burned up at one time of the year by a lack of moisture or an abundance of fertilizer, and provides aeration during the wetter part of the year when plant roots need air. Just across the road we find that the soil packs hard and is impermeable. It is the same soil type, Brookston clay loam, but has been farmed, or should we say mined, for 60 years. Organic matter to the extent of 3000 lb per acre has been removed with each row crop; this particular land was row-cropped to death. It was at one time good sugar beet land. Today the drain tile will not work, and the land resembles concrete. Alfalfa plants have a difficult time penetrating the soil with their roots. Eventually, if given time, they will restore to a certain extent the tilth of the land.

Perhaps the most important thing that happens to flat, heavy land is the loss of soil structure. To show soil structure we use two samples (Fig. 3) of soil from two plots on the Ferden farm near Chesaning. The color of each soil sample is about the same, since both are Brookston soil, yet in the first sample it may be noted that the soil is loose and full of roots, and in the second sample it has been pretty well slacked down and later cemented together. The only difference in these two soils is that resulting from different crop rotation. The land from which the first sample was taken was in alfalfa-brome rotation. The second was taken from a rotation where everything is removed from the land and nothing put back. The difference is that there is some soil structure in the first sample and none in the second. The soil in good structure can be plowed with a tractor in second gear, but low gear must be used to plow the plot having poor structure. The soil in good structure produced 7 bu more corn per acre on an 8-yr average than the other, and 3 tons more beets per acre.

The effect on the crop is quite noticeable. Every wet year poor aeration is apparent on the soils with poor structure. Crops such as corn are held back in growth, whereas corn following alfalfa, where aeration is good, generally is off to a good early start. The same is true with beans. Beans following alfalfa and beans following beans showed a marked difference on the same soil. Beans show symptoms that indicate deficiency of almost everything if aeration is poor. It is necessary to get air into soil in order for plants to grow and utilize fertility to the best advantage. Beans following alfalfa have aeration early in the year, and mature early. The beans on land in poor tilth are late and green and blossoming at frost time. They do not get aeration until in August and start growing during the latter part of that month. The effect on sugar beets is about the same as for corn and beans; the low-

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Soil and Water Division.

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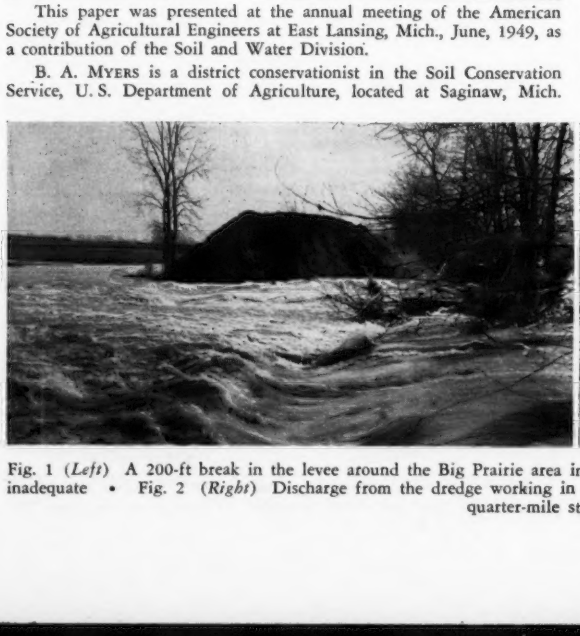


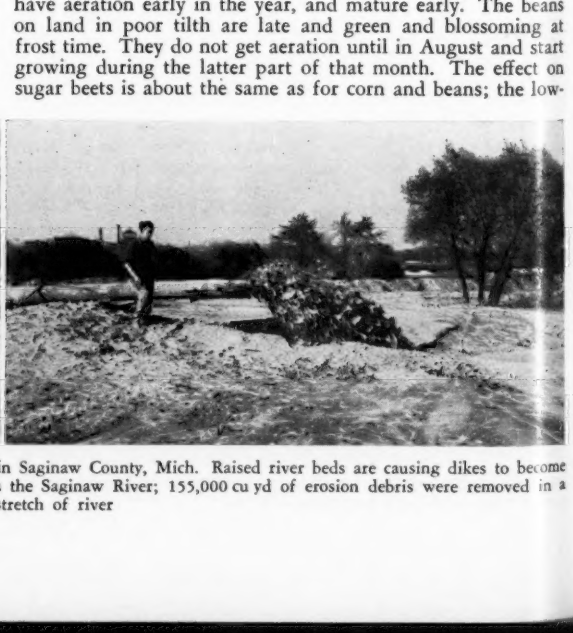


Fig. 1 (*Left*) A 200-ft break in the levee around the Big Prairie area in Saginaw County, Mich. Raised river beds are causing dikes to become inadequate • Fig. 2 (*Right*) Discharge from the dredge working in the Saginaw River; 155,000 cu yd of erosion debris were removed in a quarter-mile stretch of river

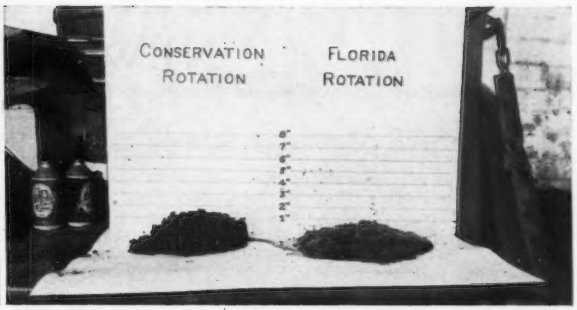


Fig. 3 (*Left*) Two samples showing soil structure taken from the Ferden plots—soil-depleting rotation and the alfalfa-brome rotation. In one case there is a good soil structure, and in the other the soil aggregates are cemented together • Fig. 4 (*Right*) Result of slump test showing the conservation-rotation soil sample standing almost intact, whereas the soil from the cash-crop rotation has slumped to almost half its original depth

est yield is from the soil having poor structure where everything is taken from the land and nothing it put back, and the highest yield follows two years of alfalfa-brome.

In order to measure the tilth or structure of soil we devised a test which is called the "slump test". It is based on a similar concrete test for excess moisture in a mix where we have aggregates, cement and water. In soil structure similar conditions exist — soil aggregates built by organic material as cement. In testing we use soil samples from a conservation rotation which includes two years of alfalfa-brome, and from a poor rotation, where everything is removed from the land. Two oil cans with an equal number of holes punctured in the bottom are filled to a depth of about 2.5 in with soil from fields having two different rotations, one from alfalfa-brome and the other from cash-farmed land (Fig. 4).

Equal amounts of water are poured on soil from both the depleting rotation and the conservation rotation. Drainage water appears through the conservation rotation soil in one or two minutes. The depleting rotation varies with the different soils and generally it takes 5, 10, or even as long as 20 min for the water to percolate through that soil. The two cans are dumped side by side for the slump test. The soil from the conservation rotation stands up when dumped. The slump is very slight. The 2.5 in of soil in the can to start with will not slump down, whereas the soil from the depleting rotation will slump down to almost half its original height, or 1.25 in. Land lacking soil structure stability puddles, it runs together, it slumps, slides, and slithers, and is unworkable. It is a "Sunday" soil; you have to work it on Sunday, Monday is too late and Saturday is too early.

There are many things we need to know and learn about the physical condition of soil. The slump test is a method of showing the condition. It is just as important as the lime, nitrogen, phosphorus, and potassium tests. If the soil does not have the proper aeration, the plants cannot utilize these plant food elements. Hard rain puddles the soil causing it to run together. Splash erosion caused by the impact of the raindrops knocks the soil particles loose, causing them to go into suspension. With good aggregation, good soil structure, this condition does not exist. After a rain, water will soak into the soil and into drain tile and will not lie on top of the soil in puddles.

What can be done to cut down on this soil loss into rivers and provide protective measures against silt going into drain ditches? The use of cover crops is perhaps the most important conservation measure on flat land. There should be no bare land over the winter because it is the fall, winter and spring rains that cause the most damage and erosion to flat heavy land. In one test sweet clover seeded in corn at the last cultivation at 20 lb to the acre made 12 in of growth by the following May. A square foot of this cover crop contains many roots.

In summary, we need to maintain organic matter in the soil so that it absorbs water and provides food for bacteria. It is necessary to maintain soil structure or tilth in the land so that it can be properly aerated and properly drained. History of drain-tile spacing indicates that at one time a space of 8 rods between tiles was acceptable. Now 4 rods is needed, and eventually 2-rod spacing of drain tile may be necessary. Instead of doing this, we must maintain the tilth of the land in order to properly aerate and properly drain heavy flat land. The effect of tilth on crops is best shown by corn yields, yet the best yields of almost any crop follow two years of alfalfa-brome on heavy land. The lowest yield is in the depleting rotation, or where corn follows corn.

As land goes, so goes man. This is an old story that has been told over and over again, but it is just as true on flat land as it is on the upland. Civilizations have come and gone with their land. Old Joe, who broke the plains and reaped a bountiful harvest, didn't take care of the land. He, like his land, is gone with the water and the wind. It has happened in these United States where we have lost more than one-third of our topsoil to date. It is happening on flat land; stopping it is just as important and perhaps even more important than on hill land. So little goes at a time that it is unnoticed, and we think we do not have erosion on flat land.

Harvesting Napier Grass in Hawaii

(Continued from page 77)

smooth field conditions and 2.57 tons per hour under rough field conditions. Table 1 indicates the economics of the various methods of forage harvesting:

TABLE 1. COST COMPARISON OF VARIOUS HARVESTING METHODS IN DOLLARS PER TON

Tons per year	Present methods	Trail-type harvesting	Hawaii self-propelled forage harvester
6000	$3.39	$1.06	$1.27
4800	3.40	1.06	1.28
3600	3.41	1.07	1.30
2400	3.45	1.09	1.31
1200	3.63	1.20	1.71
600	4.09	1.41	2.50

CONCLUSIONS

A self-propelled forage harvester can be assembled that will combine in one machine the features of self-propulsion, cutting, chopping and intermittent storing. This machine will cost a minimum of $11,500. The purchase of such a machine is justified for dairies cutting 2400 tons or more feed per year. Rates of harvesting vary from 2.6 tons per hour in rough fields to 3.6 tons per hour in smooth fields. Field speeds vary between 0.8 to 1.0 mph. The capacity of this machine is not over 8 tons per hour using a 20 hp auxiliary power unit and still have sufficient reserve power.

Mechanical harvesting has decided labor-saving advantage over present harvesting methods. Where field conditions are satisfactory, trail equipment can operate at a lower cost and a lower initial investment than a self-propelled unit. Fields which are not satisfactory for the trail harvester can be easily handled by the self-propelled machine. Where land characteristics are such that neither harvester can be operated efficiently and without undue strain or if the land acreage in crop is too small to warrant such an investment it may be best to follow the present harvesting methods.

NEWS SECTION

ASAE Meetings Schedule

IN THIS section of AGRICULTURAL ENGINEERING each month is carried a calendar of meetings of the American Society of Agricultural Engineers, the places and dates of which have been set many months in advance. The schedule, as this issue of AGRICULTURAL ENGINEERING goes to press, includes two national meetings, four regional meetings, two state section meetings, and one local section meeting.

During the second week in February will occur four of the section meetings. The Minnesota Section will meet on February 9. The Southeast Section, comprising the states east of the Mississippi and south of the Ohio and Potomac Rivers, except West Virginia, meets at Biloxi, Miss., February 9 to 11, in conjunction with the annual convention of the Southern Agricultural Workers. The Michigan Area Section, which includes the Toledo area in addition to the state of Michigan, meets at East Lansing on February 11. The Washington (D. C.) Section will hold its next regular monthly meeting February 10 at the usual place in the South Agriculture Building, with Dr. H. H. Bennett, chief, U. S. Soil Conservation Service, as the speaker.

On March 16 and 17 and the Pacific Coast Section, comprising the states of California, Arizona, Utah, and Nevada, will meet March 16 and 17. The meeting will be held in Utah, the first day at Logan, where Utah State Agricultural College is located, and the second day at Salt Lake City.

During the first week in April, the Mid-Central Section comprising the states of Missouri, Kansas, and Nebraska, will hold its yearly meeting in the Agricultural Engineering Building on the agricultural campus of the University of Nebraska at Lincoln, April 7 and 8.

The following week, on April 14 and 15, the Southwest Section, comprising the states of Oklahoma, Arkansas, Louisiana, and Texas will hold its yearly meeting on the campus of Louisiana State University at Baton Rouge.

The Society's 1950 Annual Meeting will be held in Washington, D. C., June 19-21, with headquarters at the Hotel Statler.

The Society's 1950 Winter Meeting will be held as usual at The Stevens in Chicago, on December 18 to 20.

Interspersed between the dates of the foregoing meetings will be meetings of other local, state, and regional sections, which will be announced from time to time.

Announcements of programs and other arrangements regarding national meetings will be sent to all members of the Society. Announcements of meetings of the sections will automatically be sent to members of those sections, and information concerning the section meeting programs can be obtained from officers of the section or direct from the ASAE headquarters office in St. Joseph, Michigan.

A.S.A.E. Meetings Calendar

February 9 — MINNESOTA SECTION

February 9-11 — SOUTHEAST SECTION, Buena Vista Hotel, Biloxi, Miss.

February 10 — WASHINGTON (D. C.) SECTION

February 11 — MICHIGAN AREA SECTION, Agricultural Engineering Bldg., Michigan State College, East Lansing

March 16 and 17 — PACIFIC COAST SECTION, Logan and Salt Lake City, Utah

April 7 and 8 — MID-CENTRAL SECTION, University of Nebraska, Lincoln

April 14 and 15 — SOUTHWEST SECTION, Louisiana State University, Baton Rouge

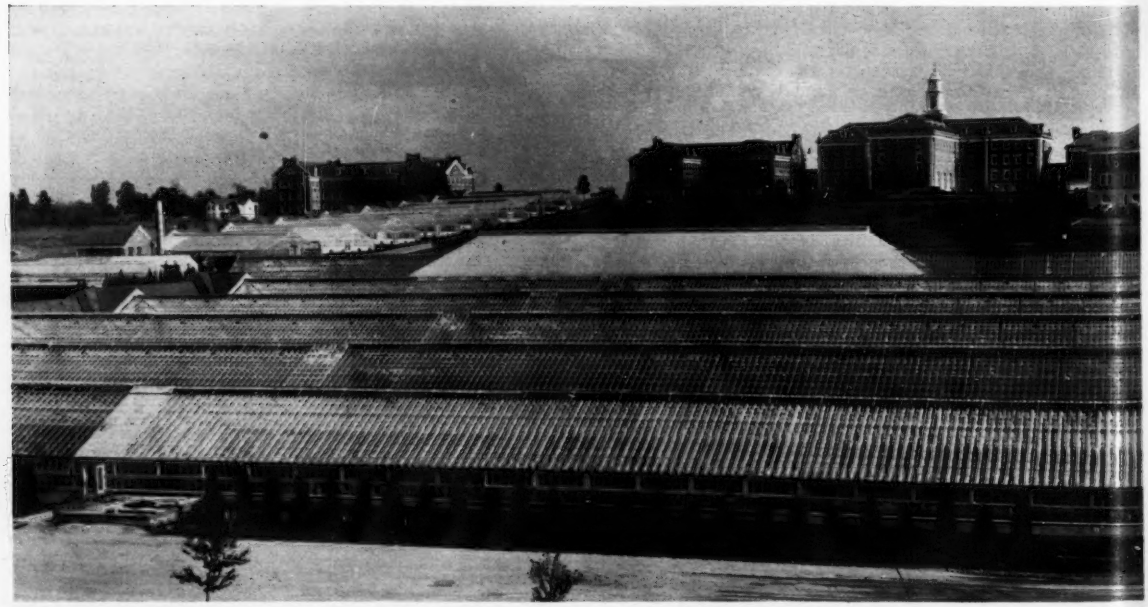
June 19-21 — ANNUAL MEETING, Hotel Statler, Washington, D. C.

December 18-20 — WINTER MEETING, The Stevens, Chicago, Ill.

Hawaii Section Meets

THE Hawaii Section of the American Society of Agricultural Engineers held a meeting on the evening of January 18 at the Agricultural Engineering Institute, University of Hawaii. The speakers were Dr. E. G. McKibben, agricultural engineer, Pineapple Research Institute of Hawaii, who spoke on some unusual land preparation machines, and E. J. Stirniman, chief engineer, Hawaii Sugar Planters Association, who discussed the problems and methods of harvesting sugar cane in Louisiana. Both speakers had just returned from extended tours of the mainland.

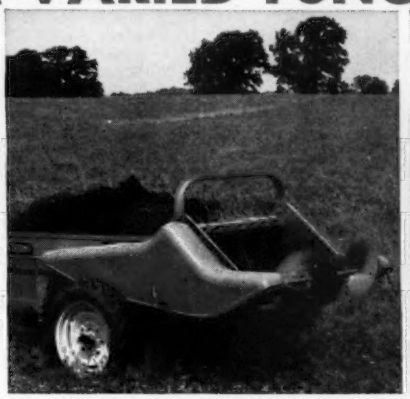
(Continued on page 82)



The close interlocking of research on plants, soils, and machines would be reason enough for carrying this picture in AGRICULTURAL ENGINEERING for in these greenhouses—covering more than 5 acres—at Beltsville, Md., a vast amount of research is done that has special interest for agricultural engineers. A better reason for using this picture, however, is to remind members of the American Society of Agricultural Engineers that the 1950 ASAE Annual Meeting will be in Washington, D. C., June 19 to 21, and the USDA Agricultural Research Center where these greenhouses are located will be one of the major points of interest. ASAE members should plan to be in Washington for the June meeting, and to take their families along with them.

LINK-BELT SCREW CONVEYORS PERFORM VARIED FUNCTIONS

As an "auger" for gathering the cut grain back of the sickle bar, the screw conveyor has become practically standard equipment on the modern combine. Link-Belt Helicoid (continuous rolled flighting) is welded to pipe of the desired diameter to form a single, efficient unit.



On the manure spreader, two short sections of screw conveyor, opposite hand, give very effective scattering action.

Post hole diggers make good use of the cutting and digging ability of Link-Belt screw conveyor.

Here is illustrated the feeding mechanism of a well-known hay-baler, which accurately feeds the hay into the press chamber.

On this cotton harvester a right and left-hand screw conveyor forwards the material in an alternate flow from the rear end of each cleaning chamber to a centrally located, inclined rear elevator.

Ten-foot flight of Link-Belt Helicoid screw conveyor feeds chopped hay and fodder into the blower, which blows hay into the mow, ensilage into the silo or grain into the granary.

The field of service for Link-Belt screw conveyor is constantly widening as engineers become increasingly aware of its unique qualities, simplicity, ruggedness, efficiency and availability in a wide range of gauges, pitches and diameters. From the original Helicoid (continuous rolled flight) and sectional flight, with special variations, design engineers can select a size and type to accomplish a special purpose, efficiently and economically, on a growing list of applications. Let Link-Belt engineers help you make effective use of this versatile element. Come to "Screw Conveyor Headquarters."

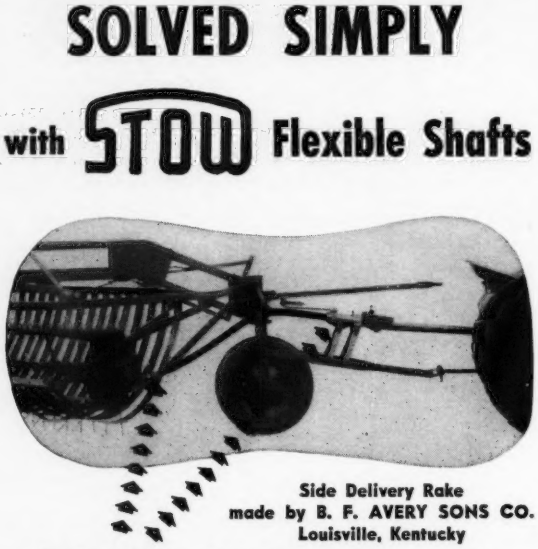
LINK-BELT COMPANY

Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

11,711

Design Engineers!

Power Transmission Problems SOLVED SIMPLY with STOW Flexible Shafts



Side Delivery Rake
made by B. F. AVERY SONS CO.
Louisville, Kentucky

- **STOW FLEXIBLE SHAFTS** simplify intricate power transmission problems by eliminating complex gearing with its close tolerance and alignment difficulties.
- **STOW FLEXIBLE SHAFTS** provide savings . . . increase design efficiency and eliminate hazards of exposed shaft assemblies.
- **WRITE TODAY FOR YOUR COPY of STOW'S NEW BOOK on FLEXIBLE SHAFTING** (included in Sweet's 1950 File for Production Designers).

LEARN HOW STOW FLEXIBLE SHAFTS HAVE BEEN SOLVING POWER TRANSMISSION PROBLEMS SINCE 1875.

STOW MANUFACTURING CO.
39 SHEAR ST. BINGHAMTON, N. Y.

NEWS SECTION

(Continued from page 80)

Washington Section Hears Wickard

THE Honorable Claude R. Wickard, administrator, Rural Electrification Administration, was the speaker at the regular monthly luncheon meeting of the Washington (D. C.) Section of the American Society of Agricultural Engineers, held January 13 in Room 6962, South Building, USDA. Mr. Wickard's subject was "The Rural Power and Rural Telephone Situation." H. Seymour Pringle, extension rural electrification specialist in the USDA Extension Service, and chairman of the ASAE Washington Section, presided as the chairman of the meeting. Total attendance at the meeting reached the 100 mark.

The meeting was followed by a meeting of the Committee on Local Arrangements headed by J. P. Schaenzer to advance plans for the ASAE Annual Meeting in Washington, June 19 to 21, for which the Washington Section will play the part of host section.

Iowa-Illinois Section Program

AT THE Rock Island Arsenal, Rock Island, Ill., the Iowa-Illinois Section of the American Society of Agricultural Engineers on Saturday, January 28, sponsored a very interesting program. The speakers and their subjects were J. D. Berwick, Goodyear Tire and Rubber Co., on rubber design, J. N. Smith, E. F. Houghton Co., on packing for hydraulic equipment, and Martin Ronning, Minneapolis-Moline Co., on farm machinery safety.

Awards Honor Frank Watts

FRANK WATTS AWARDS have recently been established by "Farm Journal," "to stimulate the promotion and sale of electrically operated farm equipment as a means of improving agricultural productive efficiency."

The awards were named in honor of Frank E. Watts, a member of the American Society of Agricultural Engineers and a distinguished leader in rural electrification, at the suggestion of a group of electric service men.

Five cash awards totaling $1000, and five plaques are to be awarded annually, the cash prizes to the farm departments of electric operating companies, and the plaques to the winning companies, "for excellence in promoting farm electrification as a productive force for better farming and better living."

The Edison Electric Institute will administer the awards which will be presented for the first time in April, 1951, for work done in 1950, based on entries submitted by the various electric operating companies.

Personals of A.S.A.E. Members

Arthur W. Cooper recently resigned as a member of the agricultural engineering staff at Purdue University, to accept appointment as research project supervisor (Project AL-R-3) of the Soil Conservation Service, USDA, and will be stationed at Auburn, Ala.

E. C. Easter, who joined the Alabama Power Co. as chief agricultural engineer in 1927, who was advanced to the position of manager of the company's rural and towns division in 1933 and last year to that of sales manager, was recently made vice-president in charge of sales for the company.

M. M. Johns was recently promoted from the position of director of the farm and home appliance department of Southern States Cooperative, Inc., to be manager of the farm supply service of SSC, and to direct both purchasing and distribution.

William M. Shepherd, for several years director of rural development, Arkansas Power and Light Co., was recently made vice-president of the company in charge of the newly created sales and development department.

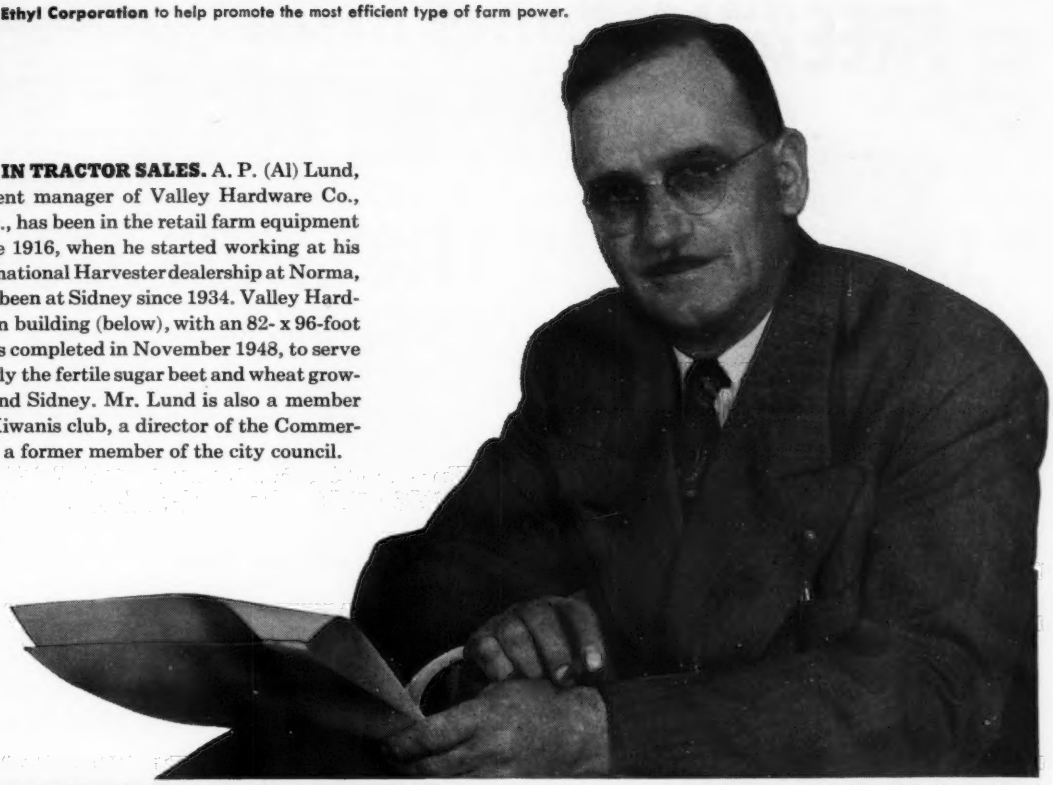
Ruth D. Whiting is now associated with the home economics department, Frigidaire Division, General Motors Corp., Dayton, Ohio.

Hiram D. Whittemore, until recently employed by the David Bradley Mfg. Works as an inspector, has accepted appointment with the U. S. Department of Agriculture to do research in long vegetable fibers and will be stationed at Belle Glade, Fla.

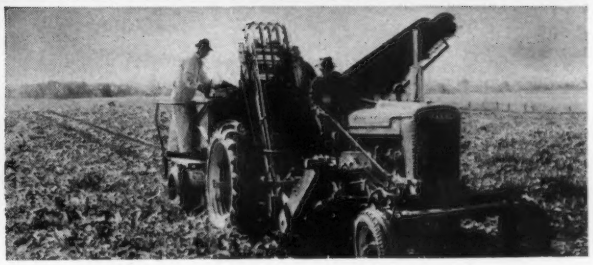
Necrology

GEORGE T. DUNLAP, JR., passed away some time ago, according to incomplete information recently received. He was born at Lexington, Va., July 29, 1923, and earned his bachelor's degree in agricultural engineering at Virginia Polytechnic Institute in December, 1948. He was elected a Junior Member of the Society early in 1949.

Published by the **Ethyl Corporation** to help promote the most efficient type of farm power.



WHO'S WHO IN TRACTOR SALES. A. P. (Al) Lund, farm equipment manager of Valley Hardware Co., Sidney, Mont., has been in the retail farm equipment business since 1916, when he started working at his father's International Harvester dealership at Norma, N. D. He has been at Sidney since 1934. Valley Hardware's modern building (below), with an 82- x 96-foot floor area, was completed in November 1948, to serve more efficiently the fertile sugar beet and wheat growing area around Sidney. Mr. Lund is also a member of the local Kiwanis club, a director of the Commercial Club and a former member of the city council.



"I'm sure farmers will continue to buy more and more high compression tractors,"

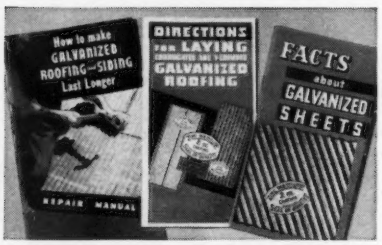
says ***A. P. Lund*** *of Valley Hardware Co., International Harvester dealer of Sidney, Montana*

"The future of the high compression tractor is fairly easy to predict. I believe the demand for high compression will grow even greater in the years ahead. Here's why:

"Farmers want a tractor that delivers plenty of power—one that will cover more land, do more work. Our new high compression Farmall models do just that. In addition, gasoline-operated tractors give quicker starting, faster warm-ups, smoother idling and cleaner burning of fuel. For these important reasons, you'll find farmers continuing to demand more and more high compression tractors."

Farmers everywhere recognize the convenience and flexibility of gasoline. And more than eighty per cent of the tractors being manufactured today have high compression engines to take full advantage of gasoline's extra power.

FREE REPAIR & PAINTING MANUALS


How to make GALVANIZED ROOFING—SIDING Last Longer
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FACTS about GALVANIZED SHEETS

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Time Proves *galvanized* sheets stay *stronger longer*. So for long-time, low-cost service, choose *galvanized* roofing and siding—strong ... fire-and-storm-proof ... economical ... "Sealed in Zinc" against rust!

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ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

"Seal of Quality" galvanized sheets carry an *extra heavy* zinc coating ... 2 oz. per sq. ft. Lasts a lifetime. No rusting. No upkeep expense. *The Super Sheet for Super Service!*

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Send me Manuals checked below, without cost or obligation.
☐ Repair Manual on Galvanized Roofing and Siding
☐ Facts about Galvanized Sheets
☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

Name_____
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Town_____ State_____

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Benson, Curtis C.—Engineer and contractor, Ossco, Minn.

Benson, Robert R.—Field representative, Applications & Loan Div., Rural Electrification Adm., USDA. (Mail) P. O. Box 104, Loveland, Colo.

Bowen, Henry D.—Graduate student in agricultural engineering, Michigan State College. (Mail) 1615 Rundle Ave., Lansing, Mich.

Brackett, Clyde H.—Manager, Home Builders Supply Co., Wilson, N. C. (Mail) Denby St.

Bruns, Paul W.—Rural representative, The Ohio Power Co. (Mail) 711 E. Main, Barnesville, Ohio

Calderwood, David L.—Fire hazard inspector, Farmers Mutual Reinsurance Co. (Mail) Manilla, Iowa

Clapp, Norman, W.—Sears, Roebuck & Co. (Mail) c/o Y.M.C.A., Nashua, N. H.

Davis, Russell G.—Sales executive, Chain Belt Co., 1600 W. Bruce St., Milwaukee 4, Wis.

DeVoe, Sherman W.—Engineer, Colorado Pump & Supply Co., Denver, Colo. (Mail) 2075 S. Adams St.

Edwards, Robert O.—Sales and service, MacLennan, MacFeeley & Prior, Ltd. (Mail) General Delivery, New Westminster, B. C., Canada

Files, John D.—29 Preble St., Gorham, Maine

Fisher, George A.—513 Kipling Blvd., Lansing, Mich.

Frohardt, Melvin W.—Engineer, J. I. Case Co., Racine, Wis. (Mail) 1118 Hayes Ave.

Gasperson, George C., Jr.—Engineering assistant, Virginia Electric & Power Co., Richmond, Va. (Mail) 2021 Monument Ave.

Gilbert, Richard M.—Service supervisor, Minneapolis-Moline Co. (Mail) R. R. 1, Worthington, Ohio

Gloss, Ralph H.—Assistant secretary and structural engineer, Timber Engineering Co., 1319-18th St., N. W., Washington 6, D. C.

Haldorson, L. L.—Field supervisor, Gilliam County PMA, Condon, Ore.

Heroux, Clement—Rural electrification, Quebec Power Co., St. Pascal, Co. Kam., Quebec, Canada

Horton, Donelson B.—Partner, Macedon Farms, R. R. 3, Madison, Ala.

Hoss, Don T.—Sales promotion manager, The Oliver Corp. (Mail) 8111 N. Woolsey, Portland 3, Ore.

Hubbell, David W.—610 Summit Ave., St. Paul 2, Minn.

Hutchinson, Reed S.—R. R. 2, Chipley, Fla.

Janssen, Leonard F.—Materials engineer, John Deere Des Moines Wks. (Mail) Ankeny, Iowa

Jay, Howard W.—State Center, Iowa

Johnson, Robert A.—Veterans agriculture instructor, Manson Public School, Manson, Iowa

Kent, Brian E.—Mechanical draftsman, development dept., Deere & Co., 301 3rd Ave., Moline, Ill.

Kleis, Robert W.—Instructor in agricultural engineering, Michigan State College, E. Lansing, Mich. (Mail) 702c Chestnut

Knowles, G. W.—District engineer, Dominion Department of Agriculture, PFRA, Macleod, Alta., Canada

Krauss, Frederick H.—Division overseer, Waialua Agricultural Co., Ltd., Waialua, Oahu, Hawaii. (Mail) P. O. Box 245

Lachey, Fred—Salesman, Franks Service Station, Austinburg, Ohio

Liebel, Calvin R.—Civil engineer, Soil Conservation Service, USDA. (Mail) Box 36, Walla Walla, Wash.

McGrath, Laurence R.—Student engineer, Allis-Chalmers Mfg. Co. (Mail) 5010-A S. 67th St., West Allis, Wis.

McIntyre, Ronald R.—Marshlands engineer, Agricultural Engineering Service, Department of Agriculture, 11 Oak St., Moncton, N. B., Canada

Mowchenko, M. E.—Instrument man, Praire Farm Rehabilitation Assistance. (Mail) Macleod, Alta., Canada

Myer, Chalmer R.—Dairy farmer, Box 9, Laplata, New Mexico

Oppenheim, T. Vincent—Market analyst, New Idea Farm Equipment Co., Div. of Avco Mfg. Co., Coldwater, Ohio

Pettus, Claude M.—Rural service engineer, Alabama Power Co. (Mail) Mobile 8, Ala.

Polley, Earl A.—Public relations, youth groups, J. I. Case Co., Racine, Wis.

(Continued on page 86)

EQUIPPED WITH GENERAL ELECTRIC MOTOR

For the best in electrified farm equipment . . .

GENERAL ELECTRIC

FarmNews

EQUIPPED WITH GENERAL ELECTRIC CONTROL

. . . look for these labels whenever you buy.

MORE POWER TO THE AMERICAN FARMER through more electricity on the farm

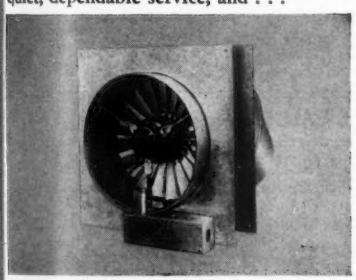
5¢ A DAY BUYS "CITY WATER SERVICE"!

WHAT IS THE "FARM NEWS"?

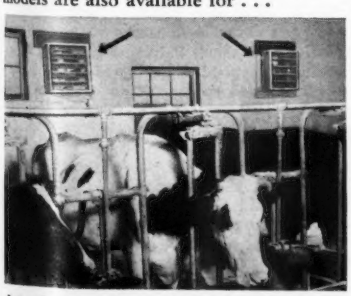
The "Farm News" is General Electric's way of bringing you news about up-to-date electrified farm equipment. G.E. does *not* make the equipment described here but supplies some or all of its electrical parts. Because the manufacturers represented on this page have a reputation for building quality equipment, G.E. is glad to call your attention to their products. Use the coupon to get more information on any of the equipment described here. We'll ask the manufacturer to send you the information you want.

NEW FARM BUILDING VENTILATORS

By maintaining circulation of fresh air, these suction-type ventilators help keep flocks and herds healthy, buildings and litter dry. They come complete and are easy to install—there's nothing to build. Their totally enclosed G-E motors assure quiet, dependable service, and . . .



low cost operation. This 10-inch poultry house ventilator (above) uses no more current than a 60-watt light bulb. It moves 300 or 500 cu. ft. of air per minute depending on the temperature. Higher capacity models are also available for . . .



dairy barn ventilation. The dairy barn ventilator (above) comes in 3 models with capacities ranging up to 2,750 cu. ft. per minute. For more complete details, check "Poultry House Ventilator" or "Dairy Barn Ventilator" in the coupon.

Mrs. A. C. Pittard, Atlanta, Ga., finds "city water service" makes her housework easier.

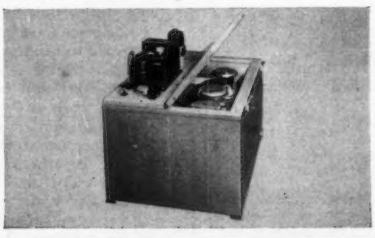
LOOK FOR THIS EXTRA!

PROTECTED MOTOR EXCHANGE PLAN

Whenever you buy motor-driven farm equipment, ask the dealer if the motor is protected by one of the G-E Motor Exchange or Service Plans. Under these plans, all G-E fractional-hp motors and most G-E integral motors up to 5-hp that become inoperative will be quickly exchanged or repaired. Here's all you do. Contact the dealer who sold you the equipment. He will immediately arrange to exchange the inoperative motor for one in good operating condition. In some cases, there may be a reasonable repair charge.

COOLS MILK FROM 90°F TO 50°F OR LOWER IN 40 MINUTES

This top-opening type cooler reduces milk temperature from 90°F to 50°F, or lower, in 40 minutes. Built of heavy-gauge galvanized steel, it is heavily insulated, and has a rustproof tank that holds 6 ten-gallon milk cans. It comes equipped with thermostatic control and is available with G-E motor and compressor. For more details, check "Milk Cooler" in the coupon.



An electric milk cooler will save enough money in ice costs alone to quickly pay for itself.

Right size, type of pump key to low-cost service

Water system comes in capacities, pressures to meet all farm needs

An automatic water system is available on the market in sizes and models that offer a wide variety of capacities and pressures. It is designed and built for shallow *or* deep well service—a dual-purpose feature which protects your investment if water levels drop during dry periods. Since the pump has only one moving part, maintenance is kept to a minimum. The pump is equipped with a G-E motor to provide reliable, quick-starting driving power, winter or summer. For further details, check "Automatic Water System" in the coupon.

A. C. Pittard, Atlanta, Ga., says his water system is the hub of his farm operations.

"ELECTRIFIED FARMING"

. . . is coming your way Look For It!

General Electric's new 16mm full-color sound movie, entitled "Electrified Farming," will be released soon! It's good entertainment, yet packed with ideas that can help you get more work done faster. Watch this page next month for further details on this film.

General Electric Company
Section D669-109
Schenectady 5, N. Y.

I would like additional information on the following equipment:

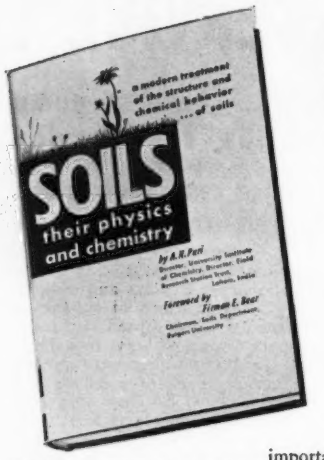
- ☐ Water System
- ☐ Poultry House Ventilator
- ☐ Dairy Barn Ventilator
- ☐ Milk Cooler

NAME_____

ADDRESS_____

CITY_____ STATE_____

Chemists, physicists and agronomists engaged in the study of soils and the improvement of their yields, will find this new book an important contribution to their work.


a modern treatment of the structure and chemical behavior ... of soils
SOILS
their physics and chemistry
by A. N. Puri
Foreword by Firman E. Bear

SOILS:

Their physics and chemistry

by *A. N. Puri*

Director, University Institute of Chemistry and Director, Field Research Station Trust, Lahore, India

with a Foreword by

Firman E. Bear

Editor-in-Chief, Soil Science, Chairman, Soils Department, Rutgers University

Results of the highest practical importance may be realized from author Puri's approach to the problems of chemistry and from the comprehensive theory presented in this book.

Dr. Puri starts with the very simple principle of acid-base equilibrium, and then proceeds to a consideration of the many highly complicated phenomena associated with the colloidal structure of soils. The chemistry of soils is reduced to the chemistry of acids and bases and the soil-water system to a solution of soil acidoids and saloids. This soil solution is subject to the laws of acid-base equilibrium. This book takes into account all the physico-chemical aspects of the soil system.

Dr. Puri's writing is interesting and lucid. He resolves complicated processes into elementary concepts. A great many of the younger students of soil phenomena will find this a highly stimulating and very thought-provoking presentation of a subject of great interest not only to soil physicists and physical chemists, but to research specialists in many other fields as well.

Special attention is accorded the soil structure of irrigation ditches, canals, roads, and airfields. Text is liberally supplemented with tables of data and charts, which back up all the theories advanced with experimental facts. "Soils" will make a mighty valuable addition to your library.

570 pages, illustrated, $7.00

GROWTH OF PLANTS

By WILLIAM CROCKER

This carefully documented and exhaustive description of the major problems relating to plant growth undertaken at Boyce Thompson Institute since its foundation, contains a wealth of technical information bearing on a wide variety of agricultural topics. $10.00

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Written by an outstanding student of entomology and agricultural technology, this book covers all the major insecticidal agents in detail, describing not only their chemical nature and properties, but also their specific action on various types of insects, their methods of application, and their effect on animals and humans. $6.00

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Applicants for Membership

(Continued from page 84)

Radke, Arthur O.—Test engineer, Association of American Railroads, Chicago, Ill. (Mail) 1845 N. Orleans

Redel, W. R.—Land inspector, Department of Lands, Quesnel, B. C., Canada. (Mail) Box 1618

Roth, Robert N.—Student research assistant, University of Wisconsin, Madison, Wis. (Mail) 1203 Chandler St.

Saunders, Robert H.—Engineer, Dominion Water & Power Bureau, 744 W. Hastings St., Vancouver, B. C., Canada

Saville, R. W.—Ralph Space & Son, "Millbrook Farm", R. R. 1, Dryden, N. Y.

Stewart, Charles D.—Agricultural engineer, PFRA. (Mail) 341 N. 2nd West, Logan, Utah

Story, Edgar P.—Middletown Springs, Vt.

Stroop, H. D.—Electrification adviser, Middle Tenn. Electric Membership Corp., Murfreesboro, Tenn. (Mail) Mounted Route

Symes, O. L.—Tractor sales representative, Ford Motor Co. of Canada, Ltd., Regina, Sask, Canada. (Mail) 746 Robison St.

Wallace, John M.—Irrigation and drainage engineer, Cia Azucarera La Estrella. (Mail) Hacienda La Estrella Aquadulee, Rep. of Panama

Ward, Elonza A.—Teacher, Alabama Department of Education. (Mail) 701 2nd St., E., Cullman, Ala.

Warner, Mardis R.—Extension agricultural engineer, University of Maine, Orono, Maine

Wilson, Charles, Jr.—District dealer manager, Lincoln Electric Co. (Mail) 19541 Lorne St., Reseda, Calif.

Wooding, Nathaniel H., Jr.—Agricultural engineer, Extension Service, Pennsylvania State College, State College, Pa.

Woodruff, Neil P.—Junior agricultural engineer, Soil Conservation Service Research Project, Kansas State College. (Mail) 1719 Anderson, Manhattan, Kans.

TRANSFER OF MEMBERSHIP GRADE

Bodwell, Walter A.—Rural supervisor, Public Service Co. of New Hampshire, Manchester, N. H. (Associate to Member)

Dobie, John B.—Assistant specialist in agricultural engineering, University of California, Davis, Calif. (Junior Member to Member)

Hopkins, R. Bruce—Designer, Allis-Chalmers Mfg. Co. (Mail) 740 Pleasant St., Waukesha, Wis.

Kinard, Drayton T.—Associate professor of agricultural engineering, University of Georgia, Athens, Ga. (Junior Member to Member)

Peak, Charles B.—Design engineer, Hardie Mfg. Co., Hudson, Mich. (Mail) 307 Pleasant St. (Junior Member to Member)

NEW BOOKS

Farm Structures, by H. J. Barre and L. L. Sammet. Cloth xi + 650 pages, 5½ x 8½ inches. Illustrated and indexed. John Wiley and Sons (New York), $7.00.

This is the first of a series of texts on agricultural engineering sponsored by the Ferguson Foundation. It was developed as a project of Purdue University. It is specifically indicated to be intended for the instruction of students seeking professional degrees in agricultural engineering. To this end its first twenty-two chapters are suggested by the authors as a suitable introduction to the subject for all professional agricultural engineering students. Seven additional chapters are provided as a further foundation for those professional students who elect to specialize in farm structures. Some matters directly related to farm structures have been omitted as more appropriate to instruction in one of the other branches of agricultural engineering subject matter.

The place of this text in the professional training program is indicated by the authors' suggestion that mechanics and strength of materials be considered as prerequisites, and that prior courses in thermodynamics, fluid mechanics, and stresses in structures would be helpful. It anticipates an analytical approach to the subject, including quantitative procedures and computations.

Chapters cover introduction, selection of materials in relation to use, materials and methods of use — wood, concrete, masonry, materials and methods of use — surfacing materials, detailing, types of structural frames, heat and heat transfer, air-water vapor mixtures, heat flow through walls — insulation, estimating heat load, temperature gradient — condensation in walls, ventilation, physiologic reactions of animals to ambient temperature and relative humidity, dairy buildings, poultry housing, principles of crop and food preservation and storage, storage of fruit and vegetable crops, storage of grains, farm houses, estimating construction costs, some economic aspects of farm buildings, building and farmstead planning for process efficiency, introduction to structural design, estimating loads, stress analysis, allowable unit stresses, design for axial loading, beams, connections, and miscellaneous problems.

FOR DEPENDABLE LONG LIFE

insist on

Nickel Alloy Steel Gears

There are two kinds of nickel alloy steel gears . . . those that are carburized, and those that are direct hardened.

CARBURIZED GEARS

The carburized gear is used in applications that require maximum wear resistance in the surface, as well as greatest surface compressive strength. With nickel alloy carburizing steels, this goal is consistently attained, together with development of extremely tough cores that resist shock loads, fatigue and bending stresses. Moreover, a chief cause of noisy gears . . . the distortion that accompanies heat treating . . . is inherently resisted by nickel alloy carburizing steels.

DIRECT HARDENED GEARS

The direct hardened steel gear is used to carry heavy tooth loading in applications where resistance to wear and surface compressive stresses is not quite so vital a factor. Here again, the nickel-containing steels develop the required strength more consistently and in heavier sections than carbon steels, and are generally more resistant to shock, fatigue and multi-axial stresses. Distortion resulting from heat treatment may be minimized by using nickel alloy steels and their machinability before final heat treatment is very good.

Giving greater play to the skill of the engineer, nickel alloyed steels not only provide increased strength without sacrificing ductility, but they harden at lower temperatures which simplifies heat treatment and minimizes deformation and scaling.

MEET VARIED REQUIREMENTS

Nickel alloyed steels enable producers to meet virtually any reasonable requirements . . . whether dictated by revised stress analysis due to design changes, or by changed fabricating methods that demand better machining qualities or improved response to heat treatment.

MANY TYPES AVAILABLE

The many standard grades of nickel alloyed steels permit specifying the particular type which provides the best set of properties for any reasonable fabrication and service demands.

Unending competition for higher speeds and heavier loads, for quieter operating and longer machine life, provide opportunities for gear producers to drive ahead with nickel alloyed steels. Use the coupon for your copy of "Modern Trends in Nickel Steel and Cast Iron Gear Materials." This useful and informative booklet is yours for the asking. Send for it now.

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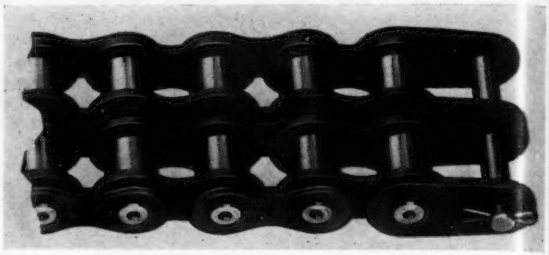
NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

New Baldwin-Rex Roller Chain Assembly. A new development in roller chain construction known as the Baldwin-Rex "BA" Assembly is announced by Baldwin-Duckworth Div., Chain Belt Co., Springfield, Mass. It is designed to simplify disassembly and assembly of roller chain on the job in the field. It combines the advantages (longer life and lower cost) of riveted chain with the advantages (ease of disassembly and assembly) of cottered roller chain. The basic assembly consists of a 5-ft length of standard riveted roller chain with a new single-pin connector assembled at approximately the 2-ft mark and at the end of the basic 5-ft length. It is necessary to remove only one pin to disconnect the chain. The new single-pin connector has a distinctive tear-drop shape for easy identification. These basic units plus standard short units make it easy to build up the exact length of riveted roller chain desired without the need for cutting the riveted chain. The new

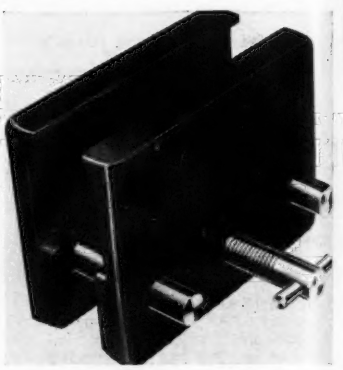


Baldwin-Rex "BA" roller chain assembly

BA assembly is available for all standard roller chains from one-inch pitch to larger sizes in both single and multiple.

• • •

Morse Steel Jaw Chain Vise. A new chain-breaking vise incorporating many exclusive features is announced by the Morse Chain Co., Detroit, Mich., a division of Borg-Warner Corp. The Morse steel jaw chain vise accommodates all American Standard sizes of roller chain from ½-in pitch to 2½-in pitch, single

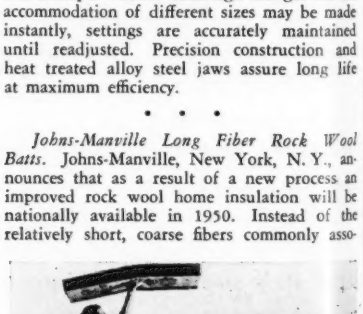


Morse chain-breaking vise

and multiple widths. Although changes for the accommodation of different sizes may be made instantly, settings are accurately maintained until readjusted. Precision construction and heat treated alloy steel jaws assure long life at maximum efficiency.

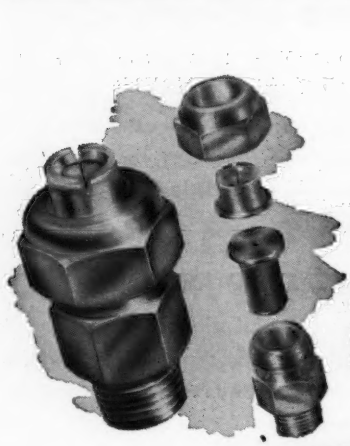
• • •

Johns-Manville Long Fiber Rock Wool Batts. Johns-Manville, New York, N. Y., announces that as a result of a new process an improved rock wool home insulation will be nationally available in 1950. Instead of the relatively short, coarse fibers commonly asso-



Johns-Manville long-fiber rock wool batts

ciated with rock wool, this new process produces fibers that are unusually long and very fine. Handling is improved and shipping costs are reduced because the new batts are more resilient and *(Continued on page 90)*



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SPRAY NOZZLES

YOUR GUARANTEE of TOP PERFORMANCE

● Specify Delavan agricultural nozzles to be sure your equipment performs at peak efficiency . . . the way you designed it!

New Delavan LS type flat spray nozzles are standard in size and feature a new design for maximum orifice protection, assuring longer life and better field performance.

Delavan nozzles are available in a wide range of types for herbicide and insecticide application; in ratings up to 100 gallons per acre.

Delavan nozzles offer you the benefit of years of research experience in the spray nozzle field. You can safely specify Delavan for any application where accuracy and precision are important.

Write for detailed information today. Our engineers will gladly assist with application data or quote to your specifications.

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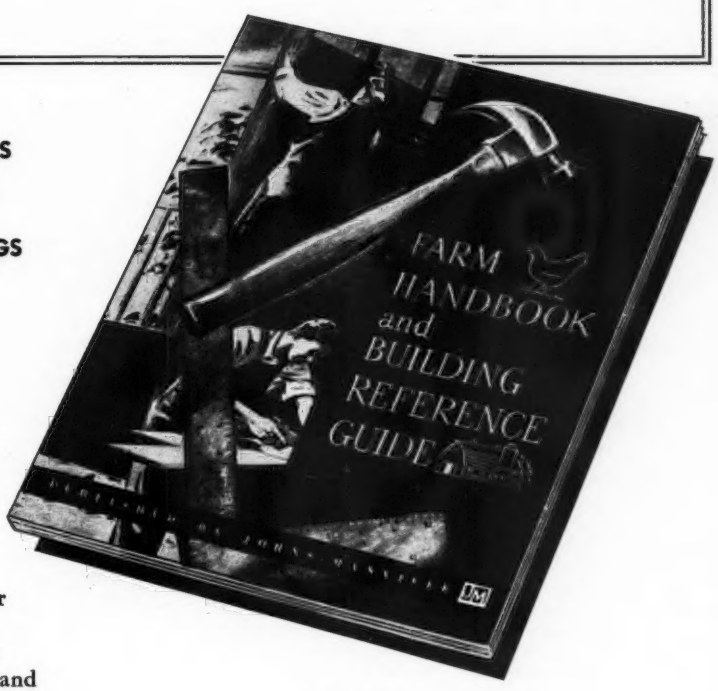
Here at last!..The Farm Building Handbook you've always wanted!

Brought together for the first time under one cover—the wealth of reference material scattered through various Federal and State College Bulletins! Simplified, condensed, fully illustrated!

266 DETAIL DRAWINGS AND PICTURES

134 PAGES—8½ x 11 INCHES

COVERS 17 TYPES OF FARM BUILDINGS



• Johns-Manville recently published for building material dealers and builders this practical new handbook on farm building that meets a long-existing need.

Since the announcement of this book, we have heard from many county agents and vo-ag teachers asking if they could obtain copies for their personal use or for veterans enrolled in institutional on-farm training programs and even for individual farmers.

As a result of these requests, we have printed an extra supply of the handbook and will be happy to fill orders at $1.50 each, from anyone interested in agriculture.

This well-illustrated volume discusses the particular requirements of structures used in various types of farming—buildings for dairying, poultry, hog raising, crop storage, beef cattle and many others. All recommendations are based on latest findings of the U.S.D.A. and State Agricultural Colleges.

ONLY $1.50 PER COPY

The 134-page *Farm Handbook and Building Reference Guide* will be sent to you promptly, postage prepaid, on receipt of check or money order. Only $1.50 per copy. Address Johns-Manville, Box 290, New York 16, New York.

*Reg. U. S. Pat. Off.

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ASBESTOS ROOFING AND SIDING SHINGLES, ASPHALT ROOFINGS AND SIDINGS, ROCK WOOL INSULATION, ASBESTOS FLEXBOARD*, INSULATING BOARDS, ROOF COATINGS AND PUTTIES, CAULKING PUTTIES, BUILDING ACCESSORIES, ETC.

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The authors discuss in detail the important technical aspects of the subject necessary for an engineering approach to farm structures problems. Essential information is included on:

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- moisture and heat transfer problems in farm buildings
- the principles of space and equipment arrangement in a functional plan
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Farm Work Simplification is a book on HOW to do things rather than on what to do. Essentially, it tells how the industrially developed techniques of scientific management and methods engineering can be applied to farm work. Four points are emphasized:

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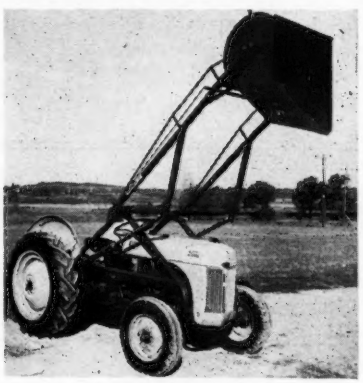
News from Advertisers

(Continued from page 88)

will spring back to full thickness after being compressed. Ten long fiber batts now can be put in the same size package that formerly held only eight. Overhead work is simpler since the strong batts will not droop or twist. They are more dependable for insulating walls. The long fibers are oriented parallel to the long dimension to assure greater strength and greater protection against sagging or settling. The batts are denser and the felting is firmer so that cut edges stay sharp and clean. The greater density of fibers increases the millions of trapped air cells that stop the leakage of heat in winter and the infiltration of heat during the summer. They come in 2-in and full-stud thicknesses, in widths of 15 or 23 in, and in lengths of 2 and 4 ft.

• • •

Dearborn Material Loaders. Dearborn Motors Corp., Detroit, Mich., announces a new standard loader which is the basic unit of three new loaders that have been added to the Dearborn line of farm equipment. Teaming up with the Ford tractor they are capable of taking over many of the hoisting and loading jobs found on the modern farm. The basic unit has a load capacity of 750 lb and can be equipped with either a material bucket, manure fork, or crane. It is operated by the hydraulic touch control. The other two loaders—the heavy-duty loader and the

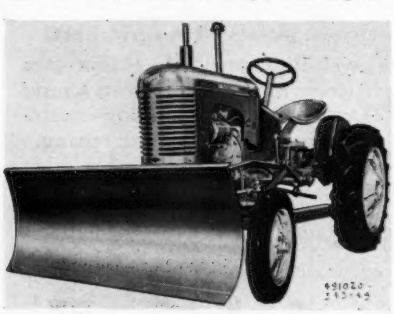


Dearborn standard material loader

heavy-duty loader with hydraulic bucket and manure fork control—use the same accessories as the basic unit but have a load capacity of 1,000 lb. The two heavy-duty loaders are operated by self-contained hydraulic pumps which leave the tractor hydraulic control free to operate a scoop, utility blade or other equipment at the rear. The hydraulic bucket and manure fork control allows the operator to control the pitch of the bucket or fork at all times when loading, digging, and dumping. Conversion kits are available to change the standard and heavy-duty loader into heavier duty loaders where new job requirements indicate.

• • •

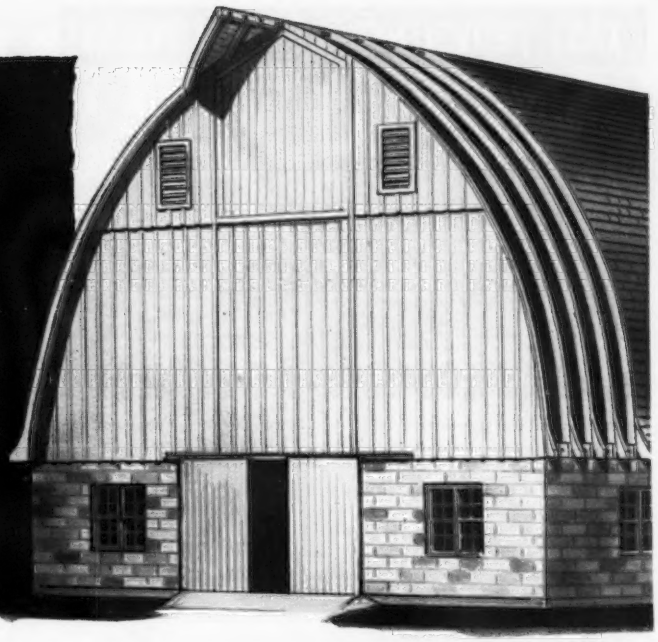
New Massey-Harris Dozer. The Massey-Harris Co., Racine, Wis., announces the new No. 40 snow plow and dozer blade, made especially to fit their Pony tractor. The welded steel frame has only 3 attaching points, two being supports on the rear axle. This, with the close-coupled mounting, gives the best possible weight distribution and traction. The heavy gage, steel blade with reversible cutting edge is curved to roll snow or trash forward or sideways as desired. The blade is easily adjustable to five positions, by simply removing two clip pins.

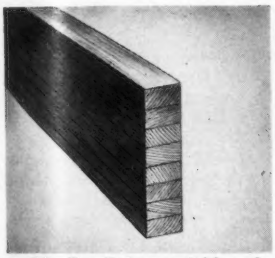


New Massey-Harris dozer

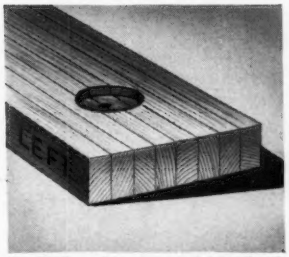
Elevations from 3-in below ground level to 8-in above are quickly and easily accomplished with the hand lift. Pivot mounting of the blade makes it free-floating to follow land *(Continued on page 92)*

Ten easy steps to a BETTER BARN

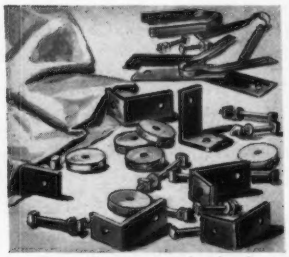




1. Rilco Barn Rafters are finish grade, kiln dried West Coast Douglas Fir laminations bonded together by super-strength structural glues under pressure. They can't warp or twist.



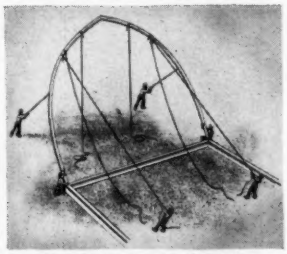
2. Each rafter is precision fitted, cut and drilled at the factory. Every one is plainly marked so even a beginner can't go wrong. There's no time-wasting sawing or fitting on the job.



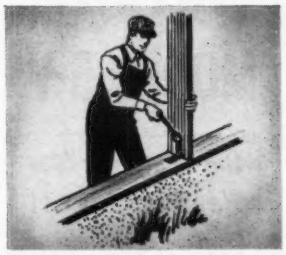
3. Every bit of connecting hardware is furnished with Rilco Rafters. Engineered connectors make use of 80% of the natural strength of the wood —make buildings more rigid and stable.

4. Nearly half the job is already done when Rilco Rafters are delivered to the barn site all ready to put up . . . and they're four times stronger than nailed rafters built on the job.

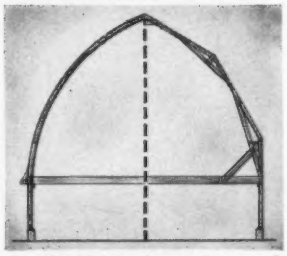
5. Building goes fast with Rilco Rafters. First, rafter halves are bolted together at the crown with special steel plates and heavy bolts furnished. Holes are already drilled so job is simple and swift.



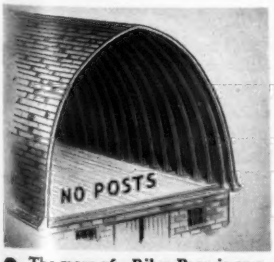
6. Next, rafter is raised with ropes and poles. With angle irons bolted to the sill or foundation, a crew can easily erect all the rafters for an average barn in less than a single working day . . . ordinarily a two-week job.



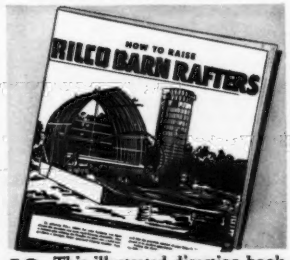
7. Rafters are securely bolted to sill with sturdy steel angle irons and engineered timber connectors. They can't "creep" or twist out of position as often happens when ordinary studs are toenailed to sill.



8. Rilco Rafters give you the strength of a single, solid, joint-free member clear from foundation or plate to roof ridge. There's no chance for loosening or sagging as in ordinary construction (right).



9. The mow of a Rilco Barn is completely free of inside posts or supports. The vaulted arch design of Rilco Rafters places the load squarely and securely on the foundation . . . gives you more space.



10. This illustrated direction book takes a barn builder through every operation step by step. Clear directions plus Rilco pre-engineering helps even unexperienced builders do a perfect job.

RILCO WORKS WONDERS WITH WOOD

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There are standard, pre-engineered Rilco Rafters, for every type of farm building from small hog and poultry houses to large post-free machine sheds, granaries and barns.

"FAST SHOVELING" at the RICE FIELDS!

THIS VANCO RICE CART

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Another Wisconsin Heavy-Duty Air-Cooled Engine assignment! . . . powering the conveyor of this VANCO RICE CART . . . shoveling off the entire rice load in three minutes flat!

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4-cycle, single-cylinder, 2-cylinder, and V-type 4-cylinder models.

Wisconsin Engine power reserve is your best assurance of jobs well-done, 3 to 30 hp.

MOST H.P. HOURS

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World's Largest Builders of Heavy-Duty Air-Cooled Engines

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MODEL 5-W

The Pump for Your Weed and Pest Control Equipment

No other pump for tractor spraying outfits combines these practical advantages of the Tuthill Model 5-W in one compact unit:

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- **Built of highly corrosion-resistant materials to handle a wide variety of spray liquids.**
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Write for complete details.

TUTHILL PUMP COMPANY

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News from Advertisers

(Continued from page 90)

contours, and springs on the blade supports immediately return the blade to the level position when the lift is operated. It takes only a few minutes to mount or demount the dozer and it may be left on the tractor for added convenience, since the drawbar is left free for general farm hauling and use.

• • •

Stow Flexible Shaft Slide Rule. The Stow Mfg. Co. has developed a new slide rule for calculating torque loads on flexible shaft equipment. This pocket size calculator is especially valuable in that it solves torque problems and indicates the size of shaft which performs most efficiently at a given rpm, within a given radius. It is available to de-

New Stow slide rule

sign engineers and business executives who are confronted with power drive problems and may be obtained by writing, on company letterhead, to the Stow Mfg. Co., Binghamton, N. Y.

• • •

Firestone Tractor Tire. The Firestone Tire and Rubber Co., Akron, Ohio, have introduced a new farm tractor tire, featuring a curved-bar, open-center tread design. Its scientific design and construction provides better traction, longer service, a smoother ride for this type of tire, and improved self-cleaning. Maximum traction is obtained by extending the open bars past the center of the tire and having them curve to the shoulder. Each bar has a 24 per cent taper from the outside shoulder to the sharper biting center section. Broader shoulder bars, extra rubber in the center of the tread supporting each bar end, and a gum-

The new Firestone tratcor tire

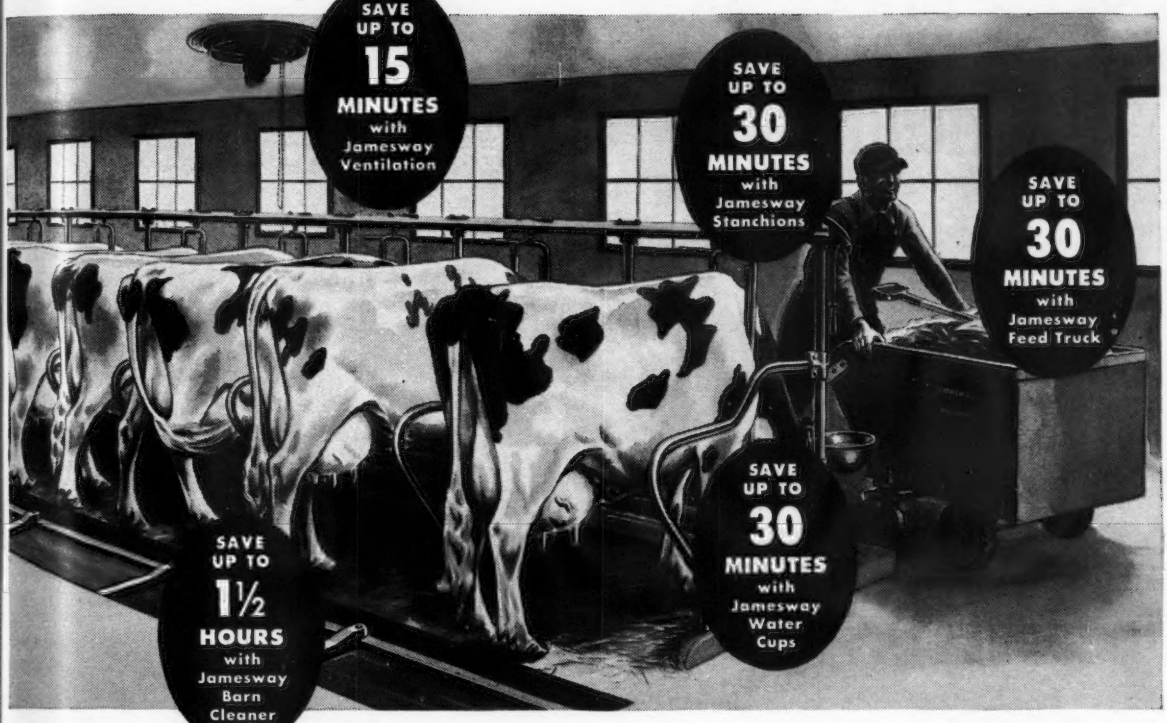
dipped cord body of heat-resisting rubber in both tread and sidewalls, increase its service and life. Improved self-cleaning and constant traction are assured because as the tread digs into and grips the soil, the curved bars go into action, squeezing the soil for the traction bite. As the individual bars pull out of the soil and the tire resumes its normal contour, the curved bars release their hold and any accumulated dirt is automatically released from the tread.

• • •

The Stow Mfg. Co., Binghamton, N. Y., will send on request a free copy of a new catalog (Catalog 50) listing details and specifications and illustrating the complete line of Stow Flexible Shaft Machines and accessories, tool shafts, power-drive shafts and drill shafts. Designed primarily as a reference book, this catalog groups Stow machines and shafts by type and use, charting performance data and specifications within each group. Thus a prospective buyer can determine, on a job basis, which of the Stow machines and accessories best serve his needs.

SAVE UP TO 3 HOURS

OF HARD, BACK-BREAKING DRUDGERY EVERY DAY


SAVE UP TO 15 MINUTES with Jamesway Ventilation
SAVE UP TO 30 MINUTES with Jamesway Stanchions
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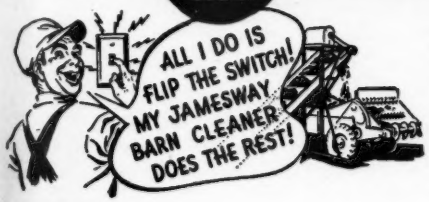
SAVE UP TO 30 MINUTES with Jamesway Water Cups
SAVE UP TO 1½ HOURS with Jamesway Barn Cleaner



NEW Jamesway Barn Cleaner does away with daily barn drudgery and saves time. Just flip the switch—it cleans your barn *cleaner.* Easy to install. Fits any gutter — any barn. No indoor pits or cross-gutters to collect filth. Exclusive shuttle action. No gutter chains or corner sprockets to wear out or break. Sturdy drive unit sits outside . . . saves valuable stall space. Ask your Jamesway dealer for a free demonstration. You'll see why the Jamesway Barn Cleaner is the leader.

SAVE EXTRA TIME WITH Jamesway PLANS AND EQUIPMENT

ASK YOUR JAMESWAY DEALER FOR *FREE* PLANNING HELP BEFORE YOU BUILD, REMODEL OR EQUIP ANY FARM BUILDING

Why put up with an old, inefficient barn that wastes steps, wastes time—makes you do everything the *hard way?* Drudgery is *expensive!* You can *free* yourself of hard back-breaking work. You can save up to 3 hours a day — with Jamesway. It's easy to modernize with Jamesway plans and equipment. Instead of working for your barn, *you'll make your barn work for you!*

See your Jamesway dealer now. He'll be glad to show you how little it costs to modernize and equip your barn. He'll even sit down and work out a plan, *tailor-made for you.* Take advantage of this personal planning service now. There's no obligation. For free literature that tells you how you can save time with dairy cows, poultry or hogs, mail coupon today.

World's Largest Makers of TIME-SAVING Equipment for Cows, Hens, Hogs

LOOK for the store with the **Jamesway** sign!

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Dairy Barn ☐ Hog House ☐ Poultry House ☐

Name.....

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SPRAYING SYSTEMS

TeeJet

SPRAY NOZZLES

FIRST CHOICE for Agricultural SPRAYING

Preferred by original equipment manufacturers, TeeJet nozzles are "first choice" today in agricultural spraying. TeeJet nozzles are precision made . . . deliver uniform spray. They are easy to install and align . . . have patented V-Groove orifice protection . . . assure accurate coverage with "Lap-Edge" spray pattern . . . minimize drift age by uniform atomization . . . convert to any type of spraying by simple interchange of orifice tips without removing body from boom. Write today for full information about the TeeJet line. Ask for Bulletin 55.

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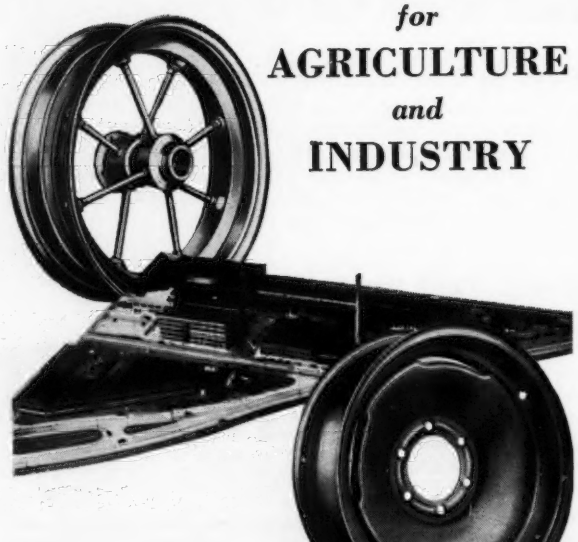
STANDARD EQUIPMENT ON AMERICA'S LEADING SPRAY RIGS AND SPRAYERS

F & H WHEELS

for AGRICULTURE and INDUSTRY



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Wheel Builders Since 1888

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN (1949): MAY — O-668, 669. AUGUST — O-34-675, 34-678, 59-680. SEPTEMBER — O-84-681, 84-682. OCTOBER — O-121-687. NOVEMBER — O-85-689, 127-690. DECEMBER — O-165-691. (1950): JANUARY — O-189-692, 194-693, 195-694, 197-695, 197-696, 201-697.

POSITIONS WANTED (1949): APRIL — W-239, 248. MAY — W-258, 268, 271. JULY — W-288, 292, 299. AUGUST — W-24-304. SEPTEMBER — W-67-312. OCTOBER — W-111-316. NOVEMBER — W-119-319. DECEMBER — W-128-321, 152-322, 145-323, 146-324, 151-325, 137-327, 157-328, 97-329, 161-330. (1950): JANUARY — W-164-331, 138--332, 174-333, 175-334, 179-335, 171-336, 177-337, 190-338, 202-339.

NEW POSITIONS OPEN

AGRICULTURAL OR MECHANICAL ENGINEERS for design and development work with farm equipment manufacturer in Midwest. Want men with several years design experience, preferably on combines, corn pickers, or grain drills. Salary open. O-232-698

NEW POSITIONS WANTED

EXTENSION, management, sales, or service in power and machinery field, with manufacturer or distributor in U.S.A., preferably in Midwest or West. BS deg in agriculture, major in agricultural engineering University of Wisconsin, 1949. Experience as assistant manager of variety store, 2 yr; U. S. Army technical clerk, 2 yr; part-time salesman for food products processor 1 yr; advertising salesman 1 yr; and research assistant 2 yr. War non-commissioned service 2½ yr in Air Force. Single. Age 25. No disability. Available now. Salary open. W-203-340

DEVELOPMENT, research, or teaching in power and machinery or soil and water field, in public service or private industry, anywhere in U.S.A. BS deg in agricultural engineering, January 1950, Oklahoma A and M College. Midwest diversified farm background, with responsibility for operation, maintenance, and repair of machineryy. With farm contractor 3 mo building ponds, terraces, and diversion ditches. War non-commissioned service in Infantry, 2 yr, with promotions to master sergeant. Married. Age 24. No disability. Salary $3000. W-198-341

EXTENSION, development, service, or research in farm structures, power and machinery, or rural electric field, with college, manufacturer, distributor or consultant in U.S.A. or elsewhere in Americas. Willing to travel extensively. BS deg in agricultural engineering expected in June, University of Vermont. Summer vacation work as carpenter, painter and laborer, past three summers. Also previous farm and labor experience. Single. Age 21. No disability. Available July 10. Salary open. W-199-342

DEVELOPMENT, extension, management, research or teaching in power and machinery field, with public service agency or private industry, preferably in Midwest. BS deg in agriculture 1949; BS deg in mechanical engineering expected June 1950, University of Wisconsin. Wisconsin dairy farm background. Part time work on farm past 3 yr. One summer as supervisor of tile drainage company. War enlisted and commissioned service in Navy 3 yr. Single. Age 24. No disability. Available July 1. Salary open. W-214-343

SALES or service in power and machinery field, in U.S.A., preferably in East, BS deg in agriculture January 1950, University of Wisconsin. Background on dairy farm with modern equipment. War service in Army Medical Corps, 14 mo. Single. Age 22. No disability. Available now. Salary $2400-2700. W-208-344

DEVELOPMENT, management, sales, service, or teaching, in power and machinery or rural electric field, with college, manufacturer, or distributor, anywhere in U.S.A. except south central area. BS deg in agricultural engineering expected in March, Michigan State College. Farming to age 29. Electrical wiring 2 yr in spare time and off seasons. Electronic repair and office work 1 yr. Traffic signal construction 3 mo. Production employee in manufacturing, 2 yr. War service 3½ yr as mechanic in tank destroyer unit. Married. Age 37. No disability. Available April 1. Salary $3000. W-218-345

SALES, advertising, or experimental work with farm equipment manufacturer, preferably in Midwest. BS deg in agricultural engineering February 5, 1950. Purdue University. Farm background. Summer experience with harvester manufacturer. War service 3 yr as radar technician. Single. Age 27. No disability. Available now. Salary open. W-222-346

DESIGN, development, or research in power and machinery field with college or manufacturer, any location. BS deg in agricultural engineering, University of Idaho, June 1949. Farm background. Tractor and combine mechanic 3 yr, during vacations and part time during school terms. With present employer 8 mo as engineer, working on design, supervision of small number of shop employees, ordering supplies, and some sales activities. War service 2 yr in Army Signal Corps. Married. Age 26. No disability. Available on 60-day notice. Salary open. W-209-347

(Continued on page 96)

Square Peqs in ~~Round~~ square Holes

Conservation is putting land to its best use . . . marginal land in timber . . . other land in grass and pasture . . . the best land in field crops. It is contouring and strip cropping the slopes . . . slowing down fast-moving streams . . . building ponds for irrigation, livestock, and recreation.

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As a result, we have seen millions of acres of cropland made useless, farms abandoned, rivers silted, much of our precious top soil gone . . . the top few inches that took Nature hundreds of years to build and the source of all new wealth.

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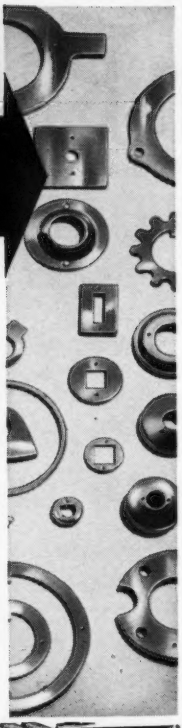

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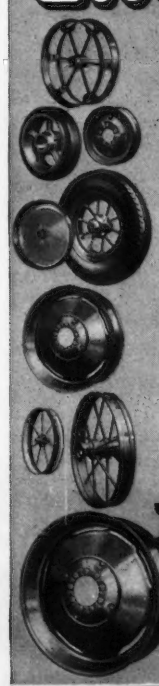

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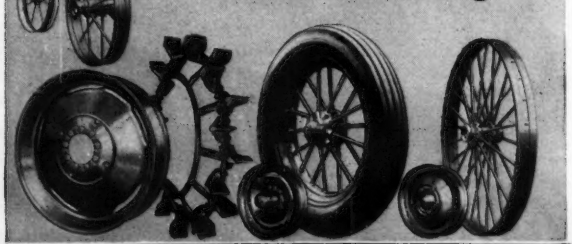

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

PERSONNEL SERVICE BULLETIN

(Continued from page 94)

DESIGN, with manufacturer of farm equipment, or promotion of rural electrification with utility or equipment distributor, in U.S.A., preferably Midwest or Northeast. BS deg in agricultural engineering Feb. 7, 1950. Pennsylvania State College. Farm background. Airplane mechanic 1½ yr. Brick molder 6 mo. Carpenter's helper one summer. Summer 1949 with electric utility on survey of electrical farm equipment. Visited approximately 500 farms. War service 20 mo, Army Air Force. Married Age 24. No disability. Available February 15. Salary open. W-217-348

DESIGN, development, extension, research, or service in power and machinery field, in public service or private industry, preferably in Midwest. BS deg, division of special service for war veterans, 1949; BS deg in agricultural engineering expected June 1950, both University of Illinois. Summer work experience as truck driver with canning company two summers, and substitute railway mail clerk one summer. War noncommissioned service 3 yr in U. S. Marine Corps. Married. Age 26. No disability. Available in June. Salary $3000. W-213-349

NEW BOOKS

Welding and Cutting Manual. Cloth, 208 pages, 6¼x9½ inches. Illustrated and indexed. The Linde Air Products Co. (30 East 42nd St., New York 17, N. Y.). No price stated.

A guide for beginners and semi-skilled oxy-acetylene welders, with chapters on the hottest flame on earth; forming, bending, and straightening metals; soldering and brazing with the air-acetylene flame; steel and cast iron cut as easily as wood; repairing and rebuilding by welding; hard-face wearing parts for long life; welding and cutting steel pipe; points to remember in welding most common metals; 100 things you can make; and how to set up and operate your outfit. An appendix gives supplementary information on welding rods, fluxes, tips, nozzles, pressures, flame adjustments, identification of metals, melting points of metals, and oxy-acetylene welding and cutting terms.

Applied Hydrology, by Ray K. Linsley, Jr., Max A. Kohler, and Joseph L. H. Paulhus. Cloth, xiv+689 pages, 6x9 inches. Illustrated and indexed. McGraw-Hill Book Co., Inc. (New York, Toronto, London). $8.50.

This is a first edition text and reference for engineering students and practicing engineers. It covers general data, basic theory, and methods of application, with particular reference to conditions within the continental United States. One notable feature is a list of symbols and abbreviations included as a contribution toward the standardization of terminology and nomenclature in this relatively new field. Chapters cover an introduction, climate, temperature in the atmosphere, atmospheric humidity, winds, precipitation, snow, ice and frost, evaporation and transpiration, streamflow, the basin, surface retention and detention and overland flow, soil physics, sedimentation, groundwater, hydrograph analysis, runoff relations, runoff distribution, waves, streamflow routing, design criteria, design and operation of water control works, and river forecasting. Appendixes cover graphical correlation, sources of hydrologic and meterological data, and physical constants, conversion tables, and equivalents.

New Bulletins

Terracing to Save Soil, by John L. McKitrick. Circular 473, Agricultural Extension Division, University of Kentucky (Lexington) July 1949. Practical information for farmers and custom terracers on reasons for terracing, effectiveness, planning, construction, maintenance, etc.